Easy to build projects for everyone

Everyday ELECTRONICS

SEPT. 79

45p

CHASER LIGHTS

VARICAP MW RADIO

personal listening

EE70 REFLEX LOUDSPEAKER

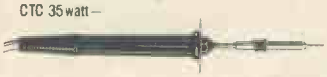
SIMPLE TRANSISTOR TESTER

ustralia 85c South Africa 85c New Zealand 85c Malaysia $2·75

Iron out the little problems...

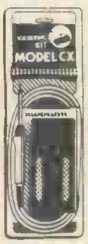
Model TCSU1 Soldering Station

CTC 35 watt –



The TCSU1 soldering station with either the **XTC** 50 watt – 24/26 volt soldering iron or the **CTC 35** watt – soldering iron for pin point precision and exceptionally fast recovery time.
We have put at least twice as much power into irons which are already known for good recovery time. The temperature control stops them from over-heating: the "fail-safe" electronic circuit provides protection even if the thermocouple fails.
TCSU1 soldering station with **XTC** or **CTC** iron. **£41.54** including VAT (Nett to Industry). Postage extra.

Model SK3 Kit



Contains both the model CX230 soldering iron and the stand ST3. Priced at **£7.19** inclusive of VAT and P&P. It makes an excellent present for the radio amateur modelmaker or hobbyist.

Model SK4 Kit

With the model X25/240 general purpose iron and the **ST3** stand, this kit is a must for every toolkit in the home. Priced at **£7.19** inclusive of VAT and P&P.

Model CX 17 watts

A miniature iron with the element enclosed **first** in a ceramic shaft, then in a stainless steel. Virtually leak-free. Only 7½" long. Fitted with a 3/32" bit. **£5.18** inclusive of VAT and P&P. Range of 5 other bits available from ¼" down to 3/64".

Model X25 - 25 watts

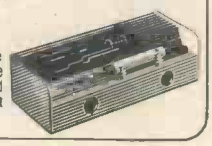
A general purpose iron also with a ceramic and steel shaft to give you toughness combined with near-perfect insulation. Fitted with 1/8" bit and priced at **£5.18** inclusive of VAT and P&P. Range of 4 other bits available.

Model MLX Kit

The soldering iron in this kit can be operated from any ordinary car battery. It is fitted with 15 feet flexible cable and battery clips. Packed in a strong plastic envelope it can be left in a car a boat or a caravan ready for soldering in the field. Price **£5.69** inclusive of VAT and P&P.

Model SK1 Kit

This kit contains a 15 watt miniature soldering iron, complete with 2 spare bits, a coil of solder, a heat sink and a booklet, 'How to solder'. Priced at **£7.48** inclusive of VAT and P&P.



...with Antex

The ANTEX multi purpose range of soldering equipment is fast becoming a must for every home. Built with precision for long life, each iron is fully tested and guaranteed.
ANTEX soldering irons are made in England to strict local and international standards of safety.

The Handy ST3 Stand

Priced at **£2.07** inclusive of VAT and P&P

A N T E X

Stocked by many wholesalers and retailers or direct from us if you are desperate.

Please send me the Antex colour brochure ☐ I enclose cheque/P.O./Giro No.258 1000 ☐

Please send the following ....

Name ....

Address ....

EE9

Antex Ltd. Freepost, Plymouth PL1 1BR Tel. 0752 67377

WATFORD ELECTRONICS

35 CARDIFF ROAD, WATFORD, HERTS., ENGLAND
MAIL ORDER, CALLERS WELCOME. Tel. Watford 40588/9

ALL DEVICES BRAND NEW, FULL SPEC. AND FULLY GUARANTEED ORDERS DESPATCHED BY RETURN OF POST. TERMS OF BUSINESS: CASH/CHEQUE/ P.O.s OR BANKERS DRAFT WITH ORDER. GOVERNMENT AND EDUCATIONAL INSTITUTIONS' OFFICIAL ORDERS ACCEPTED. TRADE AND EXPORT INQUIRY WELCOME. P&P ADD 30p TO ALL ORDERS UNDER £10·00. OVERSEAS ORDERS POSTAGE AT COST. AIR/SURFACE.

VAT Export orders no V.A.T. Applicable to U.K. Customers only. Unless stated otherwise all prices are exclusive of V.A.T. Please add 15% to total cost including P & P.

We stock many more items. It pays to visit us. We are situated behind Watford Football Ground. Nearest Underground/BR Station: Watford High Street. Open Monday to Saturday 9.00 am–6.00 pm. Ample Free Car Parking space available.

POLYESTER CAPACITORS: Axial lead type (Values are in μF)
400V: 1nF, 1n5, 2n2, 3n3, 4n7, 6n8, 10m, 15n 9p; 18n 10p; 22n, 33n 11p; 47n, 68n 14p; 100n 17p; 150n, 220n, 24p; 330n, 470n 41p; 680n 52p; 1μF 53p.
160V: 39μF, 100n, 150n, 220n 11p; 330n, 470n 19p; 680n, 1μF 22p; 1μ5, 2μ2 23p; 4μ7 36p.
1000V: 10nF, 15n, 20p; 22n 22p; 47n 26p; 100n 38p; 470n 53p; 1μF 175p.

POLYESTER RADIAL LEAD (Values in μF) 250V:
10nF, 15n, 22n, 27n, 5p; 33n, 47n, 68n, 100n 7p; 150n 10p; 220n, 330n 13p; 470n 17p; 680n 19p; 1μF 22p; 1μ5 30p; 2μ2 34p.

FEED THROUGH CAPACITORS
1000μF 350V 8p

ELECTROLYTIC CAPACITORS: Axial lead type (Values are in μF) 500V: 10 40p; 47 68p; 250V: 100 65p; 63V 0·47, 1·0, 1·5, 2·2, 2·5, 3·3, 4·7, 6·8, 8 10, 15, 22 8p; 47, 32, 50 12p; 83, 100 27p 50V 50, 100, 220 25p; 470 32p; 1000 50p; 40V: 22, 33, 9p; 100 12p; 2200 68p; 3300 68p; 4700 85p; 35V: 10, 33 7p; 330, 470 32p; 1000 49p; 25V: 10, 22, 47 6p; 80, 100, 160 8p; 220, 250 13p; 470, 640 25p; 1000 27p; 1500 30p; 2200 45p; 3300 68p; 4700 85p; 16V: 10, 40, 47, 68 7p; 100, 125 8p; 220, 330 14p; 470 16p; 1000, 1500 20p; 2200 34p; 10V: 100 6p; 640 12p; 1000 14p.
TAG-END TYPE: 70V: 4700 135p; 64V: 2200 89p; 3300 99p. 50V: 10,000 255p; 40V: 2500 65p; 3300, 4700 74p; 15,000 299p; 24V: 4700 79p; 2200 48p; 325V: 200+100+50+100 190p; 32+32 175p

TANTALUM BEAD CAPACITORS 35V: 0·1μF, 0·22, 0 33, 0·47, 0·68, 1·0, 2·2μF, 3·3, 4·7, 6·8 25V: 1·5, 10 20V: 1·5 16V: 10μF 13p each 47, 100 40p. 10V: 22μF, 33 20p 6V: 47, 68, 100, 30p 3V: 68, 100μF. 20p

MYLAR FILM CAPACITORS
100V: 0·001, 0·002, 0·005, 0·01μF 6p
0·015, 0·02, 0·04, 0·05, 0·056μF 7p
0·1μF, 0·2 9p 50V: 0·47 12p

MINIATURE TYPE TRIMMERS
2-5·6pF, 3-10pF, 10-40pF 22p
5-25pF, 5-45pF, 60pF, 88pF 30p

COMPRESSION TRIMMERS
3-40pF, 10-80pF 30p; 25-190pF 33p
100-500pF 45p

POLYSTYRENE CAPACITORS
10pF to 1nF 8p; 1·5nF to 10nF 10p.

SILVER MICA (Values in pF) 3-3, 4-7, 6-8, 10, 12, 18, 22, 33, 47, 50, 68, 75, 82, 85, 100, 120, 150, 180 9p each
220, 250, 300, 330, 360, 390, 600, 820 16p each
1000, 1200, 1800, 2000 20p each

CERAMIC CAPACITORS: 50V
0·5pF to 10nF 3p; 22n to 100n 6p.

E.E. INTRUDER ALARM
All parts now available

POTENTIOMETERS: (ROTARY)
Carbon Track. 0·25W Log & 0·5W Linear Value.
500 Ω, 1 K & 2K (Lin. only) Single 27p
5K-2 M Ω single gang 27p
5K-2 M Ω single with DP switch 65p
5K-2 M Ω double gang 78p

SLIDER POTENTIOMETER
0·25W log and linear values 60mm
5K Ω-500K Ω single gang 70p
10K Ω-500K Ω dual gang 80p
Self Stick Graduated Bezels 25p

PRESET POTENTIOMETERS
Vertical & Horizontal
0-1W 50 Ω—5MΩ Miniature 8p
0-25W 100 Ω—3·3M Ω Horiz 10p
0-25W 200 Ω—4·7MΩ Vert 10p

RESISTORS—Erie make 5% Carbon Miniature High Stability, Low noise

	RANGE	VAL	1 99	100+
¼W	2-2Ω- 4 7M	E24	2p	1p
½W	2-2Ω- 4 7M	E12	2p	1p
1W	2-2 Ω 10M	E12	5p	4p
2% Metal Film	10 Ω-1MΩ		6p	4p
1% Metal Film	51 Ω-1M		10p	8p

100 + price applies to Resistors of each type not mixed values.

LW to MW Converter for Radio 4
Complete kit of parts inc. Instructions. £4·95 inc. VAT

OPTO ELECTRONICS
LEDs plus clips

TIL209 Red	13
TIL211 Grn	17
TIL212 Yellow	18
·2" Red	15
2" Yellow Green	18
Square LED	48
ORP12	63
2N5777	45
7 Seg Displays	
LS400	255
TIL312 C An 3"	105
TIL313 C Cth 3"	105
TIL321 C An 5"	115
TIL322 C Cth 5"	115
DL704 C Cth ·3"	99
DL707 C.A. ·3"	99
DL747 C.A. ·6"	180
FND357	120
MAN3640	175
LCD 3½ digit	875
TIL307	675

SWITCHES
TOGGLE 2A 250V

SPST	28p
DPDT	38p
4 pole on/off	54p
SUB-MIN TOGGLE	
SP changeover	59p
SPST on/off	54p
DPDT 6 tags	70p
DPDT c/off	79p
DPDT Biased	115p
SLIDE 250V:	
1A DPDT	14p
1A DP c/off.	15p
½A DPDT	13p
4 pole c/over	24p
PUSH BUTTON Spring Loaded	
SPST on/off	65p
SPDT c/over	70p
DPDT 6 Tag	85p

VOLTAGE REGULATORS*

		+ve		−ve	
1A	**TO3**				
5V	7805	145p	7905	220p	
12V	7812	145p	7912	220p	
15V	7815	145p		—	
18V	7818	145p		—	
1A	**TO220 Plastic Casing**				
5V	7805	80p	7905	90p	
12V	7812	80p	7912	90p	
15V	7815	80p	7915	90p	
18V	7818	85p	7918	90p	
24V	7824	85p	7924	90p	
100mA	**TO92 Plastic Casing**				
5V	78L05	30p	79L05	65p	
6V	78L62	30p		—	
8V	78L82	30p		—	
12V	78L12	30p	79L12	65p	
15V	78L15	30p	79L15	65p	

CA3085	95	LM323K	625	MVR5	150
LM300H	170	LM325N	240	MVR12	150
LM305H	140	LM326N	240	TAA550	50
LM309K	135	LM327N	270	TBA625B	95
LM317K	350	LM723	39	TDA1412	150

S-DEC 250p
T-DEC 400p
U-DEC 'A' 465p
U-DEC 'B' 699p

SWITCHES ★ Miniature Non-Locking
Push to Make 15p Push to Break 25p
ROCKER: SPST on/off 10A 250V 23p
ROCKER: Illuminated (white)
Lights when on: 3A 240V 52p
ROTARY: (ADJUSTABLE STOP) 1 pole/ 2-12 way 2p/2-6W, 3p/2-4W, 4p/2-3W. 41p
ROTARY: Mains 250V AC, 4 Amp 45p

DIL SOCKETS ★ (Low Profile – Texas)
8 pin 10p; 14 pin 12p; 16 pin 13p; 18 pin 16p; 20 pin 22p; 24 pin 25p; 28 pin 39p; 40 pin 50p.

JACKSONS VARIABLE CAPACITORS

Dielectric 100/300pF	140p	0 2 365pF with slow motion Drive	325p
500pF	165p	00 208/176	285p
6 1 Ball Drive 4511/DAF	115p	,, ,, with slow motion drive	325p
Dial Drive 4103 6 1/36 1	650p	C804-5pF 10 15 25 50 pF	175p
Drum 54mm	40p	100, 150pF	250p
0-1·365pF	245p	'L' 3 x 310pF	495p
00 2 365pF	275p	00·3 x 25pF	430p

DENCO COILS

'DP' VALVE TYPE		RDT2	92p
Range 1 to 5 Bl., Rd., Yl. Wht.	86p	RFC 5 chokes	91p
6–7 B.Y.R.	75p	RFC 7 (19mH)	96p
1·5 Green	92p	1 FT 13; 14; 15; 16; 17	86p
'T' 1 to 5 Bl., Yl., Rd., Wht.	93p	1 FT 18/1·6	99p
B9A Valve Holder	25p	1 FT 18/465	105p
		TOC 1	86p
		MW5FR	82p
		MW/LW 5FR	102p

VEROBOARD

	0·1 (copper clad)	0·15 (copper clad)	0·15 (plain)
2½ × 3¼	46p	39p	24p
2½ × 5	55p	50p	31p
3¾ × 3¾	55p	50p	—
3¾ × 5	62p	67p	43p
2½ × 17	169p	135p	92p
3¾ × 17	218p	180p	120p
4¾ × 17	280p	—	183p
Pkt of 35 pins			30p
Spot face cutter			85p
Pin insertion tool			120p

DIODES

AA119	25
AA129	20
BA100	10
BY126	12
BY127	12
CRO33	148
OA9	75
OA47	12
OA70	12
OA79	15
OA81	15
OA85	14
OA90	7
OA91	6
OA95	8
OA200	9
OA202	8
IN914	4
IN916	5
IN4001/2	5
IN4003	6
IN4004/5	6
IN4006/7	7
IN4148	4
IS44	20
3A/100V	18
3A/400V	20
3A/600V	27
3A/1000V	30

ZENERS
Range 2V7 to 39V 400mW 8p each
Range 3V3 to 33V, 1·3W 15p each

NOISE
25J 160

BRIDGE RECTIFIERS (plastic case)

1A/50V	20
1A/100V	22
1A/200V	25
1A/400V	29
1A/600V	34
2A/50V	35
2A/100V	44
2A/200V	46
2A/400V	53
2A/600V	65
4A,100V	72
4A/200V	75
4A/400V	79
4A/600V	105
4A/800V	120
6A/100V	73
6A/200V	78
6A/400V	85
BY164	56
VM18 DIL	40

SCRs Thyristors

0·6A/200V	30p
0·8A/100V	30p
0·8A/200A	35p
1A600V	70
5A300V	35
5A600V	43
8A300V	48
8A500V	58
8A600V	85
12A300V	59
12A500V	92
15A/700V	195p
2N444	140p
BT106	150
C106D	38
TIC44	25
TIC45	45

TRIACS

3A100V	48
3A200V	49
3A400V	50
8A100V	54
8A400V	64
8A800V	108
12A100V	60
12A400V	70
12A800V	130p
16A100V	95
16A500V	150
25A800V	295
25A1000V	480p

DIAC
ST2 25

TTL 74

7400	11	74126	57
7401	11	74128	74
7402	11	74132	73
7403	12	74136	65
7404	12	74141	56
7405	18	74142	209
7406	28	74143	314
7407	38	74144	314
7408	17	74145	65
7409	17	74147	175
7410	11	74143	109
7411	20	74150	99
7412	17	74151	64
7413	30	74153	64
7414	45	74154	96
7416	30	74155	53
7417	30	74156	80
7420	16	74157	67
7421	29	74159	185
7422	17	74160	82
7423	27	74161	92
7425	27	74162	92
7426	36	74183	92
7427	27	74164	105
7428	35	74165	105
7430	17	74166	140
7432	25	74167	200
7433	40	74170	185
7437	30	74172	625
7433	33	74173	120
7440	15	74174	87
7441	74	74175	87
7442	63	74176	75
7442	115	74177	78
7444	112	74178	153
7445	94	74180	85
7446	94	74181	165
7447	57	74182	88
7443	51	74184	135
7450	17	74185	135
7451	17	74188	275
7453	17	74190	95
7454	17	74191	95
7460	17	74192	98
7470	23	74193	98
7472	25	74194	98
7473	32	74195	98
7474	25	74196	93
7475	38	74197	80
7476	36	74198	150
7480	48	7150	175
7481	86	75491	92
7482	69	75492	92
7483	72	**74LS***	
7484	95	74LS00	11
7485	75	74LS01	11
7486	31	74LS02	12
7489	140	74LS03	12
7490	30	74LS04	12
7491	75	74LS05	23
7492	38	74LS08	22
7493	32	74LS09	22
7494	78	74LS10	20
7495	65	74LS11	22
7496	57	74LS12	23
7497	189	74LS13	38
74100	119	74LS14	75
74105	62	74LS15	30
74107	29	74LS20	20
74109	54	74LS21	22
74110	54	74LS22	22
74111	68	74LS26	48
74112	125	74LS27	28
74116	198	74LS28	48
74118	83	74LS30	22
74119	149	74LS32	27
74120	115	74LS33	39
74121	25	74LS37	39
74122	46	74LS38	39
74123	48	74LS40	28
74125	38	74LS42	98

74LS47	63	74LS365	65
74LS51	24	74LS366	65
74LS54	28	74LS367	65
74LS55	30	74LS368	66
74LS63	150	74LS373	180
74LS73	46	74LS375	160
74LS74	41	74LS374	155
74LS75	48	74LS378	184
74LS76	40	74LS670	248
74LS78	40	74LS673	1050
74LS83	115	74LS674	1450
74LS85	118		
74LS86	43	**CMOS**	
74LS90	38	4000	13
74LS91	104	4001	13
74LS92	89	4002	15
74LS93	89	4006	87
74LS95	116	4007	18
74LS96	116	4008	82
74LS107	44	4009	33
74LS109	55	4010	38
74LS112	55	4011	18
74LS113	50	4012	18
74LS114	50	4013	45
74LS123	70	4014	80
74LS124	180	4015	82
74LS125	60	4016	45
74LS126	60	4017	82
74LS132	95	4018	87
74LS136	55	4019	48
74LS138	85	4020	99
74LS139	85	4021	95
74LS151	96	4022	85
74LS153	76	4023	22
74LS155	96	4024	66
74LS156	96	4025	19
74LS157	76	4026	180
74LS158	96	4027	45
74LS160	128	4028	81
74LS161	98	4029	99
74LS162	138	4030	58
74LS163	102	4031	205
74LS164	114	4032	100
74LS165	75	4033	145
74LS168	155	4034	116
74LS169	150	4035	111
74LS170	288	4036	325
74LS173	105	4037	100
74LS174	106	4038	108
74LS175	110	4039	320
74LS181	398	4040	105
74LS183	298	4041	80
74LS189	430	4042	75
74LS190	140	4043	94
74LS191	140	4044	95
74LS192	132	4045	145
74LS193	130	4046	128
74LS194	166	4047	87
74LS195	136	4048	58
74LS196	100	4049	46
74LS197	140	4050	48
74LS221	96	4051	72
74LS240	236	4052	72
74LS241	231	4053	72
74LS242	232	4054	110
74LS243	232	4055	123
74LS244	155	4056	134
74LS245	270	4059	480
74LS247	190	4060	115
74LS251	134	4061	1425
74LS253	142	4062	999
74LS257	110	4063	110
74LS258	110	4066	58
74LS259	160	4067	380
74LS261	450	4068	22
74LS266	52	4069BE	20
74LS273	244	4070	32
74LS275	250	4071	21
74LS279	66	4072	21
74LS280	250	4073	21
74LS299	468	0475	23
74LS323	468	4076	85
74LS324	240	4077	40

4078	21	CA3123E	200
4081	20	CA3130	85
4082	21	CA3140	70
4085	74	ICL7106E	795
4086	73	ICL7107	975
4089	150	ICM7205	1159
4093	85	ICM7217A	790
4094	190	ICM7555	89
4095	105	LD130	452
4096	105	LM300H	170
4097	372	LM301A	30
4098	110	LM308	110
4099	145	LM318	195
4160	109	LM324	68
4161	109	LM339	70
4162	109	LM348	90
4163	109	LM379	375
4174	110	LM380	80
4175	99	LM381	145
4194	108	LM381AN	248
4408	720	LM382	125
4409	720	LM1458	50
4410	720	LM3900	60
4411	958	LM3909N	70
4412V	1380	LM3911	125
4415F	795	M253AA	795
4415V	795	MC1304P	260
4419	280	MC1310	149
4422	545	MC1312P	195
4433	995	MC1488	85
4435	825	MC1489	90
4440	1275	MC1495	350
4450	295	MC1496	92
4451	295	MC1710	79
490F	695	MC3340P	120
4490V	525	MC3360P	120
4501	19	MC3401	52
4502	120	MC3403	135
4503	69	MFC6040	97
4506	51	MK50362	670
4507	55	MK50398	635
4508	298	MM5303	635
4510	99	MM5307	1275
4511	150	NE518	210
4512	98	NE543	210
4520	108	NE544	185
		NE555	22
		NE556	660
LINEAR IC's		NE560	325
702	75	NE561	395
709C 14 pin	35	NE562	410
710	67	NE564	425
723	38	NE565	120
733	125	NE566	160
741C 8 pin	18	NE567	170
747C	78	NE571	420
748C	36	SAD1024	1350
753	150	SN76003	170
810	159	SN76013	140
8038CC	340	SN76023	140
AY-1-0212	580	SN76033	175
AY-1-1313	650	SN76477	225
AY-1-1320	315	TEAA621	250
AY-1-5050	190	TBA120F	70
AY-1-5051	145	TBA641	250
AY-1-6721/6	195	TCA965	120
AY-3-8500	390	TDA1008	310
AY-5-1224A	260	TDA1022	575
AY-5-1230	450	TDA1024	105
CA3011	82	TDA2020	320
CA3018	68	TLO61	76
CA3020	170	TLO74	199
CA3023	170	TLO81	48
CA3028A	80	TLO82	96
CA3035	240	TLO83	105
CA3043	190	TLO84	130
CA3046	71	UAA170	198
CA3048	210	UAA180	198
CA3080E	80	ZN414	85
CA3081	190	ZN424E	130
CA3805	85	ZN425E	415
CA3809E	210	ZN1034	200
CA3090AQ	398		

TRANSISTORS

AC125	20	BC171	11	BF179	30	MPSU06	56	ZTX302	20	2N3707	11
AC126	20	BC172	11	BF180	35	MPSU56	60	ZTX303	25	2N3708	11
AC127	20	BC177	18	BF194	12	OC26	170	ZTX304	24	2N3709	11
AC128	20	BC178	16	BF195	12	OC28	150	ZTX314	24	2N3710	16
AC141	24	BC179	18	BF196	12	OC35	130	ZTX326	40	2N3711	12
AC142K	38	BC182	9	BF197	14	OC36	130	ZTX341	20	2N3713	215
AC176	24	BC182L	11	BF198	18	OC41	48	ZTX500	15	2N3771	233
AC188	24	BC183	9	BF200	30	OC42	48	ZTX501	15	2N3772	195
ACY17	35	BC183L	11	BF224A	18	OC43	55	ZTX502	19	2N3773	283
ACY18	40	BC184	9	BF244	30	OC44	31	ZTX503	15	2N3819	22
ACY19	40	BC184L	11	BF256	60	OC45	28	ZTX504	25	2N3820	45
ACY20	40	BC187	28	BF257	30	OC46	28	ZTX531	25	2N3882	130
ACY21	35	BC212	10	BF258	30	OC70	28	ZTX550	25	2N3823	95
ACY22	40	BC212L	11	BF259	30	OC71	28	2N526	58	2N3866	90
ACY28	40	BC213	10	BF594	40	OC72	42	2N696	36	2N3903	20
ACY39	78	BC213L	12	BF595	38	OC76	36	2N697	25	2N3904	18
AD140	70	BC214	10	BFR39	25	OC77	76	2N698	44	2N3905	18
AD149	70	BC214L	13	BFR40	28	OC81	50	2N699	54	2N3906	17
AD161	42	BC307B	20	BFR41	28	OC82	50	2N706	19	2N4037	52
AD162	42	BC328	15	BFR79	28	OC83	48	2N708	19	2N4058	17
AF114	40	BC338	12	BFR80	28	OC84	44	2N918	40	2N4061	17
AF115	40	BC441	36	BFR81	28	OC140	110	2N930	18	2N4859	65
AF116	40	BC461	36	BFX29	28	OC170	85	2N961	61	2N5135	42
AF117	40	BC447	25	BFX81	45	OC171	75	2N1131	22	2N5136	42
AF139	35	BC547	12	BFX84	26	OC202	95	2N1132	22	2N5138	20
AF178	70	BC548	12	BFX85	28	TIP29	43	2N1302	35	2N5179	60
AF180	70	BC549	13	BFX86	28	TIP29C	60	2N1303	50	2N5180	80
AF186	50	BC557	15	BFX87	28	TIP30	47	2N1304	50	2N5191	70
AF239	42	BC558	20	BFX88	28	TIP30C	65	2N1305	28	2N5305	40
BC107	11	BC559	20	BFY50	20	TIP31	50	2N1671B	215	2N5457	32
BC107B	11	BCY70	18	BFY51	20	TIP31A	52	2N2160	350	2N5458	32
BC108	11	BCY71	20	BFY52	20	TIP31B	58	2N2219A	22	2N5459	32
BC108B	11	BCY72	20	BFY71	20	TIP31C	66	2N2220A	25	2N5485	35
BC108C	12	BD131	45	BRY39	39	TIP32A	58	2N2222	20	2N5777	45
BC109	11	BD132	45	BSX20	18	TIP32C	75	2N2369	15	2N6027	40
BC109B	12	BD133	43	BSY65	30	TIP33A	85	2N2476	125	3N128	112
BC109C	12	BD135	38	BSY95A	18	TIP33C	105	2N2484	25	3N140	112
BC117	20	BD136	37	BU105	140	TIP34A	85	2N2646	48	40311	60
BC119	23	BD137	36	BU205	190	TIP34C	110	2N2894	30	40313	125
BC137	20	BD138	50	BU208	225	TIP35A	185	2N2904	22	40316	86
BC140	35	BD139	40	MJ491	160	TIP35C	220	2N2905A	22	40317	52
BC142	30	BD140	36	MJ2955	120	TIP36C	255	2N2906	22	40324	85
BC143	30	BD145	198	MJE340	54	TIP41A	63	2N2926G	10	40326	52
BC147	8	BD222	75	MJE370	58	TIP41B	73	2N3053	20	40327	62
BC148	8	BD659A	65	MJE371	60	TIP42A	72	2N3054	55	40348	105
BC149	8	BO696A	65	MJE2955	99	TIP42B	82	2N3055	48	40360	43
BC153	27	BDY17	195	MJE3055	70	TIP2955	65	2N3121	40	40361	45
BC154	27	BDY60	110	MPF102	66	TIP3053	65	2N3133	43	40407	52
BC157	10	BDY61	165	MPF103	38	TIS43	34	2N3135	33	40411	295
BC158	11	BF115	34	MPF104	36	TIS44	45	2N3250	30	40412	65
BC159	11	BF154	25	MPF105	40	TIS90	20	2N3442	140	40467	95
BC160	42	BF156	29	MPF106	40	TIS91	24	2N3663	26	40576	190
BC167A	11	BF167	30	MPSA05	25	ZTX107	12	2N3702	11	40594	30
BC168C	12	BF173	25	MPSA06	25	ZTX108	12	2N3703	14	40673	68
BC169C	12	BF177	24	MPSA12	42	ZTX109	14	2N3704	11		
BC170	18	BF178	25	MPSA55	25	ZTX300	13	2N3705	11		
				MPSA56	25	ZTX301	15	2N3706	11		

Matched pair add 20p per pair

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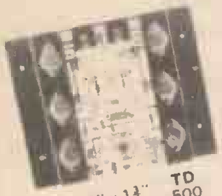
ULTRA QUALITY HIGH POWER
New D.C. Coupled Design
AMPLIFIERS



7" x 9" x 1¾" TD 500

Featuring
Electronic Short Open & Thermal Overload Protection.
Brief Spec.
Input Sensitivity 0.775.v. R.M.S. (O.D.B.) at 25 K Ohms
Frequency Response 20 Hz-20 KHz
Hum & Noise – 100 dB Relative full output

T.H.D. at full power 0.1%

T.D. 500 300W into 2 Ohms	
220W into 4 Ohms	
140W into 8 Ohms	£47.95
Power supply P.S. 300	£31.95
T.D. 150 150W into 4 Ohms	
100W into Ohms	£27.95
Power supply P.S. 150	£21.00
T.D. 150, 60 Version 60W into 8 Ohms	
40W into 15 Ohms.	£21.00
Power supply P.S.60	£16.50

Note P.S. 300 will drive 2 T.D. 150 amplifiers

5" x 5" x 2" TD 150

All output ratings are R.M.S. continuous sine wave output.

AMPLIFIER MODULES

SPEC. INPUT SENSITIVITY 60 mV for full output
Frequency response 20 Hz-20 KHz
HUM & NOISE – 70dB

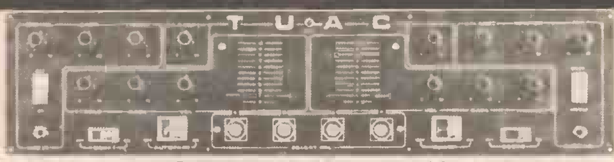
TL30 5" x 5" x 2" • 35 watt 10 amp output transistors	£15.00
TL60 5" x 5" x 3" • 60 watt R.M.S. continuous sine wave output • 2 R.C.A. 110 watt 15 amp outpout transistors	£19.75
TL100 5" x 5" x 3" • 100 watt R.M.S. continuous sine wave output • 2 R.C.A. 150 watt 15 amp output transistors	£22.95
TP125 7" x 6½" x 3" • 125 watt R.M.S. continuous sine wave output • 4 R.C.A. 150 watt 15 amp output transistors	£29.25

4 CHANNEL SOUND TO LIGHT SEQUENCE CHASER - 4LSMI

- Full wave control
- RCA 8A Triacs
- 1000W per channel
- Fully supressed and fused
- Switched master control for sound operation from ¼W to 125W
- Speed control for fixed rate sequence from 8 per minute to 50 per second
- Full logic integrated circuitry with optical isolation for amplifier protection

£22.95

Model 501 500W per channel as above without sound triggering
£14.95



STEREO DISCO MIXER
With touch sensitive switching and auto fade

INPUTS: Four identical stereo inputs available with any equalisation. Two magnetic and two flat supplied as standard. High quality slider control on each channel. Volume, treble and bass controls for each pair of sliders. Sensitivity mag., 3mV (R.I.A.A. comp.). Flat 50mV at 1kHz. Bass controls ± 18dB at 60Hz Treble controls ±18dB at 15kHz.
OUTPUT: Up to 3 volts (+ 12dB) available. Attenuated output for TUAC Power Modules. Rotary master and balance controls. Band width 15Hz - 25kHz ± dB.
P.F.L.: Output 250mV into 8 ohms. Rotary volume control. Monitoring facility for all 4 channels. Selection via touch sensitive illuminated switches. Switched visual cue indicator.
Miscellaneous Facilities: Two illuminated deck on/off switches. Mains illuminated on/off switches. Auto fade illuminated on/off switch. Mains powered with integral screen and back cover. Complete with full instructions.
Size 25in long × 6in high × 3in deep

£189.00

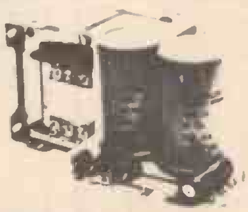
Mono Disco Mixer with autofade **£55.50**

3 CHANNEL LIGHT MODULATOR SILMB

- RCA 8A Triacs
- 1000W per channel
- Each channel fully suppressed and fused
- Master control to operate from 1W to 125W
- Full wave control

£22.95

POWER SUPPLIES



Vacuum varnish impregnated. Transformers with supply board incorporating pre-amp supply:

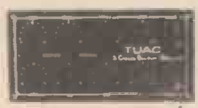
PS250 for supplying 2 TP125s	£30.00
PS200 for supplying to TL100s	£30.00
PS60/60 for supplying 2 TL60s	£30.00
PS125 ± 45 volts for TP125	£18.50
PS100 ± 43 volts for TL100	£17.00
PS60 ± 38 volts for TL60	£15.50
PS30 ± 25 volts for TL30	£11.75
PSU 2 for supplying disco mixer	£7.50

FRONT PANEL FOR LIGHTING EFFECT MODULES
(complete with switches, neons and knobs) as illustrated

For S1LMB **£9.75**
Size 8" x 4½"

4LSM1 **£7.75**
Size 6½" x 4½"

FUZZ LIGHTS
Red, Green, Blue, Amber. **£25.95**



S1LMB **£10.00**
Combined with 3SDM1
Size 9" x 4½"

STOCKISTS—CALLERS ONLY
A1 Music, 88, Oxford Street, Manchester (Tel 061-236 0340)
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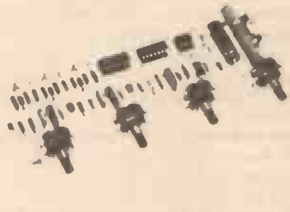
Cookies Disco Centre, 126/128, West Street (Tel Crewe 4739)
Garland Bros. Ltd., Deptford Broadway, London 01-692 4412
Luton Disco Centre, 88, Wellington Street, Luton (Tel Luton 411733)
Session Music, 163, Mitcham Road, Tooting (Tel 01-672 3413). Mon-Sat 10am to 6pm. Closed Wed.
Electrosure Ltd., Four St., Exeter. Tel. 56687.
Salcoglen Ltd., 43 Borough Rd., Cleveland, Middlesbrough. (Tel. 242851).
Menhouse Ltd., 82, St. Mary St., Southampton. (Tel 28028)
Electra Centre, 58 Lancaster Road, Preston (Tel. Preston 58488)
TRADE & EXPORT ENQUIRIES 01-672 3137

ADD SEQUENCE CHASING + DIMMING EFFECTS FOR TUAC 3 CHANNEL LIGHT MODULATOR



- Speed Control 3 per min. to 10 per sec.
- Full logic integrated circuitry
- Dimmer control to each channel

3SDMI **£17.50**

SUPPLIERS TO H.M. GOVT. DEPTS. MANUFACTURED AND ASSEMBLED IN GT. BRITAIN FULLY TESTED AND GUARANTEED
SEND NOW FOR OUR FREE 28 PAGE ILLUSTRATED CATALOGUE. SEND STAMP PLEASE

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CAPACITORS

Electrolytic Axial Leads — Order Code: Cap 015 + μF + V d.c.
−10% to +50% Tol

μF	16	25	40	63
1.0				8
1.5				8
2.2				8
3.3				8
4.7				8
6.8			8	9
10		7		9
15	7		8	10
22		7		12
33	7		8	
47		7	10	12
68	8			
100		8	12	
150	8	9		29
220	12		24	34
330			28	37
470		21	30	44
680	19	28	36	50
1000	23	28	55	
1500	32	36		
2200	39			

Electrolytic Can Type — Order Code: Cap HR + μF + Volts
High Ripple, IEC Grade 1, Low E.S.R.
Supplied complete with Vertical Fixing Clip

Capacity	Volts	Ripple 1A @ 85°C	1.4A @ 50°C	Price
2200 μF	16V			166
4700 μF	16V	2.6A	3.6A	184
10000 μF	16V	5.8A	8.1A	222
22000 μF	16V	9.8A	13.7A	346
2200 μF	25V	1.3A	1.8A	175
4700 μF	25V	4.6A	6.4A	201
10000 μF	25V	8.0A	11.2A	264
22000 μF	25V	12.8A	17.9A	438
1000 μF	40V	0.9A	1.2A	168
2200 μF	40V	2.4A	3.3A	188
4700 μF	40V	5.6A	7.8A	231
10000 μF	40V	9.2A	12.8A	367
1000 μF	70V	1.8A	2.5A	190
2200 μF	70V	4.0A	5.6A	235
4700 μF	70V	7.5A	10.5A	376
1000 μF	100V	4.0A	5.6A	222
2200 μF	100V	7.8A	10.9A	346

Miniature Low Value — Order Code

Polystyrene, Axial, ±1% Tol., ≥ 63V D.C. Wkg — Cap 424
Ceramic Plate, Radial, Low K, 1.8pF–8.2pF ±.25pF Tol, 10-330pF ±2% Tol, 100V D.C. Wkg — Cap 632
Ceramic Plate, Radial, Med K, ±10% Tol, 100V D.C. Wkg — Cap 630
Ceramic Plate, Radial, High K, −20% to +80% Tol, 63V D.C. Wkg — Cap 629
+ Value

pF	424	632	630	629
1				
1.2				
1.5				
1.8		5		
2.2		5		
2.7		5		
3.3		5		
3.9		5		
4.7		5		
5.6		5		
6.8		5		
8.2		5		
10		5		
12		5		
15		5		
18		5		
22		5		
27		5		
33		5		
39		5		
47		5		
56		6		
68		6		
82		6		

pF	424	632	630	629
100	16	6		
120	16	8		
150	16	8		
180	16	6		
220	16	6		
270	18	8		
330	18	8		
390	18		5	
470	18		5	
560	16		5	
680	16		5	
820	16		5	
1000	16		5	5
1200	16		5	
1500	18		6	
1800	18		6	
2200	18		6	6
2700	18		6	
3300	18		6	
3900	18		6	
4700	23		7	6
5600	23			
6800	23			
8200	23			

nF	424	632	630	629
10	25			6
12	26			
15	26			
18	27			
22	28			8
27	38			
33	41			
39	43			

Tantalum Bead — Order Code: Cap PR + μF + Volts
±20% Tol.

μF	3.15	6.3	10	16	25	35
0.1						9
0.15						9
0.22						9
0.33						9
0.47						9
0.68						9
1						9
1.5						10
2.2				9		11
3.3				9	11	14
4.7				10	14	15
6.8		9		11	15	16
10		10	11	14	16	20
15		11	14	15	20	
22	11	14		16		
33		15	16	20		
47		16	20			
68	16	20				
100	20					

Electrolytic Radial Leads — Order Code: Cap 034 + μF + Volts
−10% to +50% Tol.

μF	6.3	10	16	25	35	40	50	63
.47								6
.68								6
1.0								6
1.5								6
2.2								6
3.3								6
4.7						6		7
6.8				6			7	8
10			6			7		8
15			6	7			8	10
22		6	7			8	10	
33			7	8		10		
47		7	8		10			
68			8	10				
100		8	10					
150		10						
220	10							

Polyester Radial Leads — Order Code

Dipped Type, ±20% Tol, > 250V D.C. Wkg. C280/352 Style — Cap 352
Moulded Type, ±10% Tol, ≥100V D.C. Wkg. 10.2mm Pitch Centres — Cap 360
Moulded Type, ±10% Tol; ≥100V D.C. Wkg. 7.6mm Pitch Centres — Cap PHE280
+ Value

μF	352	360	PHE280
.001		5	6
.0015		5	6
.0022	5	6	7
.0033	5	6	7
.0047	5	6	7
.0068	5	6	7
.01	5	6	7
.015	5	7	8
.022	5	7	8
.033	5	7	8
.047	5	7	8
.068	6	8	9
.1	6	8	9
.15	7	9	
.22	8	10	
.33	10		
.47	12		
.68	15		
1.0	19		
1.5	27		
2.2	32		

Trimmers — Order Code

250V D.C. Wkg. Film Dielectric, Miniature

1.4 – 4.1pF	19	Cap 808 A
2 – 8pF	19	Cap 808 B
2 – 20pF	21	Cap 808 C
5.5 – 59.5pF	29	Cap 808 D

500V D.C. Wkg. C004 EA Tubular Type — Order Code

.8 – 3.8pF	46	Cap 802 3
.8 – 6.8pF	48	Cap 802 6
1 – 13pF	61	Cap 802 12
1.7 – 19.7	62	Cap 802 18

CASES

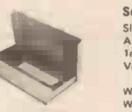
Small Desk Console — Boss Industrial Mouldings
Slope Front Console, Recessed Top
ABS Base, C/W Brass Bushes, In Orange
1mm Aluminium Top Panel Finished Grey

		Order Code
W161, D96, H39 (57)	186	Case BIM1005 OR
W215, D130, H47 (73)	268	Case BIM1006 OR

Plastic Boxes — Boss Industrial Mouldings
Moulded Box and Close Fitting Flanged Lid
ABS Box, C/W Brass Bushes, and Lid In Orange

		Order Code
L112 W62 D31	87	Case BIM2003 OR
L150 W80 D50	115	Case BIM2005 OR
L190 W110 D60	195	Case BIM2006 OR

Instrument Case — Boss Industrial Mouldings
Covers Manufactured from 14SWG Aluminium
Chassis Manufactured from 18SWG Mild Steel
Covers Finished Orange
Chassis Finished Matt Black



		Order Code
W250 D167.5 H 68.5 (Chassis 153mm Deep)	1480	Case BIM3000 OR

Plastic Boxes with Metal Lids — Boss Industrial Mouldings
Recessed Top Box
ABS Base, C/W Brass Bushes, In Orange
1mm Aluminium Top Panel Finished Grey

		Order Code
L85 W56 D29	97	Case BIM4003 OR
L111 W71 D42	130	Case BIM4004 OR
L161 W96 D53	182	Case BIM4005 OR

Diecast Boxes — Boss Industrial Mouldings
Diecast Box and Flanged Lid
Aluminium Box and Lid in Natural Finish

		Order Code
L113 W63 D31	104	Case BIM5003 NA
L152 W82 D50	181	Case BIM5005 NA
L192 W113 D61	280	Case BIM5006 NA

VERO ELECTRONICS PRODUCTS

2.5" x 5" .1" pitch Veroboard	59	VERO 21069J
3.75" x 5" .1" pitch Veroboard	66	VERO 21072D
2.5" x 1" .1" pitch Veroboard (5)	70/Pack	VERO 21076C
3.75" x 5" .1" pitch Plain Board	56	VERO 21078E
5.82" x 2.9" .1" pitch V-Q DIP Board	111	VERO 21084E
Spot Face Cutter	89	VERO 21013A
Pin Insertion Tool for .040 type pin	122	VERO 21015F
DS Pins .040 (100)	38/Pack	VERO 21087G
SS Pins .040 (100)	38/Pack	VERO 21017B
6mm Board Standoff (100)	181/Pack	VERO 21321K
15mm Board Standoff (100)	215/Pack	VERO 21322G
19mm Board Standoff (100)	226/Pack	VERO 21323D
Verowire Kit (1-pen, 2-wire, 25-comb)	375/Kit	VERO 21341D
Verowire Combs (100)	407/Pack	VERO 21339F
Verowire Wire (4)	228/Pack	VERO 21340G
Flip Top Box, Small, Black	192	VERO 21317D
Flip Top Box, Large, Black	250	VERO 21319J

Small Desk Consoles — Boss Industrial Mouldings
Slope Front Console, Recessed Top
ABS Base, C/W Brass Bushes, In Orange
1mm Aluminium Top Panel Finished Grey
Ventilation Slots In Base

		Order Code
W105 D143 H32 (56)	206	Case BIM6005 OR
W170 D143 H32 (56)	271	Case BIM6006 OR
W170 D214 H32 (82)	375	Case BIM6007 OR

All Metal Desk Consoles — Boss Industrial Mouldings
Slope Front Console, Recessed Top
Two Piece All Aluminium Construction
Ventilation Slots In Rear and Base
Choice of 15° or 30° Sloping Front
Off White Top Panel, Blue Base

			Order Code
W102 D140 H28 (51) 15° slope		1018	Case BIM7151A
W165 D211 H33 (76) 15° slope		1350	Case BIM7154A
W254 D287 H33 (76) 15° slope		1572	Case BIM7156A
W356 D287 H33 (76) 15° slope		1823	Case BIM7158A
W102 D140 H28 (76) 30° slope		1018	Case BIM7301A
W165 D183 H28 (102) 30° slope		1202	Case BIM7303A
W254 D259 H28 (102) 30° slope		1572	Case BIM7306A
W356 D259 H28 (102) 30° slope		1823	Case BIM7308A

Eurocard Size Desk Console — Boss Industrial Mouldings
Slope Front Console
ABS Case, C/W Brass Bushes, In Orange
1mm Aluminium Top Panel, Finished Grey

		Order Code
W169 D127 H45 (70)	375	Case BIM8006 OR

HARDWARE

Order Code

D.I.L. Sockets

8 Pin Low Profile Socket Tin	11	DIL SKT 8
14 Pin Low Profile Socket Tin	13	DIL SKT 14
16 Pin Low Profile Socket Tin	14	DIL SKT 16
24 Pin Low Profile Socket Gold	66	DIL SKT 24
28 Pin Low Profile Socket Gold	78	DIL SKT 28
40 Pin Low Profile Socket Gold	127	DIL SKT 40

Heatsinks

Individual Type for 1 x T05 50°C/W	10	Sink 5F
Individual Type for 1 x T066 10.5°C/W	26	Sink TV2
Individual Type for 1 x T03 7.2°C/W	24	Sink TV3
Individual Type for 1 x T0126 17°C/W	23	Sink TV4
Individual Type for 1 x T0220 17°C/W	23	Sink TV5

P.C.B. Components

Dalo Pen, Blue Ink, Slow Drying	92	Pen 33PC

Fuseholders
Suit 20mm x 5mm fuses.

P.C.B. Mounting, Open Type	8	Fuse/H20B
Chassis Mounting, Open Type	17	Fuse/H20C
Panel Mounting, Screwdriver Slot	77	Fuse/H20PT
Panel Mounting, Finger Release	56	Fuse/H20P

Fuses
20mm x 5mm Glass

Quick Blow, Range 100mA–5A	8	Fuse 20
Slow Blow, Range 250mA–5A	22	A/S Fuse 20

+ Rating

Lampholders, Panel Mounting
Similar In Style to Fuse/H 20P
Low Voltage Type Suits LES and M/F Bulbs.

Low Voltage, Red, Amber or Green	75	Lamp LV
Internal Neon 200/240V Red or Amber	95	Lamp N

+ Colour

Bulbs, Low Voltage, L.E.S.

6V, 0.36W; 6.5V, 1W; 14V, 0.75W.	22	Bulb LES

+ Voltage

RESISTORS

Carbon Film, Fixed — Order Code

0.25W, E24 Values 1R0-10M, 5% Tol.	1.5 ea.	90p/100 (Mult 10/Value)	£7.90/1000 (Mult 100/Value)	Res RD¼
0.5W, E12 Values 1R0-4M7, 10% Tol.	2 ea	1.25p/100 (Mult 10/Value)	£10.10/1000 (Mult 100/Value)	Res RD½

+ Value

Metal Film, Fixed

0.5W, E24 Values, 5R1-1M, 2% Tol.	6 ea	3.80/100 (Mult 10/Value)	£32.40/1000 (Mult 100/Value)	Res MR30
2.5W, E12 Values 10R-27K, 5% Tol.	13 ea.	7.90/100 (Mult 10/Value)		Res PR52

+ Value

Metal Glaze, Fixed

0.5W, E24 Values, 1M-33M, 5% Tol.	10 ea.	5.40/100 (Mult 10/Value)	Res VR37

+ Value

Skeleton Presets, Miniature — Order Code

0.1W, E3 Values, 100R-1M, Lin. Vertical Mounting	7	Min Preset V
0.1W, E3 Values, 100R-1M, Lin. Horizontal Mounting	7	Min Preset H

+ Value

Skeleton Presets, Standard

0.3W, E3 Values, 100R-4M7, Lin. Vertical Mounting	10	Std Preset V
0.3W, E3 Values, 100R-4M7, Lin. Horizontal Mounting	10	Std Preset H

+ Value

Potentiometer, Rotary

0.5W, E3 Values, 1K-2M2 Lin.	34	Pot Lin
0.25W, E3 Values, 4K7-2M2 Log.	34	Pot Log

+ Value

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Projects... Theory...
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The Citizens Band Radio lobby with influential support from its industrial backers has made a determined effort to convince the government that CB should be legalised in the UK. The Home Office is now actively considering the matter and a further announcement on the subject is expected in the coming months.

We believe there is considerable popular support for CB. Since, however, a decision to legislate in favour of such a service would be an irrevocable step, all the problems as well as the advantages of CB must be carefully considered beforehand. We must certainly heed the experiences of those countries which have legalised CB.

The "rights" of individuals freely to communicate with one another over the air has to be weighed carefully against the abuse of this facility that would certainly be indulged in by a minority. It might be asked, are we to suffer a new kind of vandalism? The work of the libertine with an aerosol paint can is all too permanently obvious in our cities and suburbs. Are we about to place in the hands of similarly irresponsible anti-social types quite sophisticated means whereby nuisance, if not actual offence, could be caused to ordinary innocent listeners in indescriminate fashion at anytime?

The authorities are unable to effectively police the Amateur Bands, where pirates are active, often in a most obnoxious way. Is it conceivable that the authorities would be more successful in monitoring the vastly greater number of CB transmitters that would soon be in operation? The administration machinery to "book" and prosecute offenders would be costly, to say the least.

The only alternative we can fall back upon is self-policing by CB users themselves. The acceptance of a code of conduct and the ostracising of deliberate and persistent offenders—these are vital educational matters to which the lobbyists for CB should now be directing their own attention. This much they owe to that large number of potential users of CB whose support they appear already to have secured.

Whether a "fun thing", a social amenity, an undoubted blessing for the lonely, or a swift bringer of aid in an emergency, the possibility of legalised two-way radio contact between members of the public is an attractive and appealing proposition. In today's permissive social climate, and recognising the "state of the art" in telecommunications design, it is hard to resist the demand of the ordinary individual to be freed from the virtual prohibition imposed on this form of communication for the past 75 years, ever since the first Wireless Telegraphy Act became law in 1904.

Fred Bennett.

Our October issue will be published on Friday, September 21. See page 577 for details.

Readers' Enquiries

We cannot undertake to answer readers' letters requesting modifications, designs or information on commercial equipment or subjects not published by us. All letters requiring a personal reply should be accompanied by a stamped self-addressed envelope.

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Everyday ELECTRONICS

VOL. 8 NO. 9 SEPTEMBER 1979

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BEGINNERS PLEASE!
see page 577
TEACH-IN 80

MEDIUM WAVE VARICAP RADIO

for Personal Listening

By R. A. Penfold

VARIABLE CAPACITANCE DIODES (sometimes called varicaps) have been popular for use in the tuning circuits of f.m. receivers for a number of years now, but they are not used to anything like the same extent in a.m. sets. One reason for this is probably that all the early varicaps were only capable of fairly low capacitance swings, and were therefore unsuitable for tuning over the m.w. or l.w. bands in a single range.

USE IN F.M.

One of the main advantages of varicaps in f.m. receivers is that the tuning diode can be mounted near to the appropriate inductor while the tuning potentiometer can be as far away as one desires.

The wiring to v.h.f. tuned circuits has to be extremely short, and so an ordinary tuning capacitor has to be mounted very close to the associated inductor(s), which is often inconvenient. Finally, preset switched tuning is popular in f.m. sets where only a few stations are available and varicaps are ideal for this type of tuning.

COMPONENTS approximate cost £8.50 excluding case

NOVEL ALTERNATIVE

It must be admitted that in an ordinary a.m. radio varicap tuning has no real advantages. On the other hand it has no serious disadvantages either, and to the home-constructor a.m. varicaps offer a novel alternative to an ordinary tuning capacitor and have considerable interest value. Although the use of a varicap results in some increase in circuit complexity, the rather high cost of tuning capacitors means that there is little difference in the cost of the two systems.

The simple varicap - tuned receiver described here provides coverage of the entire m.w. band and has an output which is suitable for a crystal earphone. It is reasonably compact with the case dimensions being only about 120 x 65 x 40mm, and is easy to construct.

VARICAP BASICS

A capacitor merely consists of two plates of a conducting material separated by a thin insulating layer known as the *dielectric*. The value of a capacitor is governed by several factors, two of which are the effective plate area and the thickness of the dielectric. An ordinary variable capacitor provides a varying effective plate area to give an adjustable capacitance, as will be obvious if one of these components is carefully inspected.

A varicap uses a dielectric of variable thickness to provide an adjustable capacitance, but this is not an effect which can be directly observed.

DEPLETION LAYER

Modern diodes are made from two pieces of semiconductor material which are fused together. When reverse biased, connected so that the diode does not conduct, an insulating layer known as the *depletion layer* is formed between the two pieces of semiconductor.

In effect, the semiconductor materials form the two plates of the capacitor and the depletion layer acts as the dielectric. The thickness of the depletion layer varies with the level of the reverse bias, increased bias voltage producing greater thickness. This gives the diode a capacitance value which *decreases* with *increasing* bias voltage.

This effect is produced by all diodes, and the main difference between a varicap and any other diode is that it has been designed to give certain capacitances (within reasonable tolerances) from given bias voltages. In the case of an a.m. varicap it must also be designed to provide an unusually high capacitance swing.

BASIC CIRCUIT

The basic method of using a varicap diode is shown in Fig. 1. A stabilised voltage is applied to a potentiometer, and a variable voltage is available at the slider of this component. The input voltage must be stabilised of course, as otherwise any voltage fluctuations due to battery ageing etc. would produce a shift in the tuning.

TUNING VOLTAGE

The tuning voltage is applied to the varicap via a high value resistor as there would otherwise be virtually a short circuit on the varicap at very low tuning voltages. This would not upset the operation of the varicap, but a low resistance in parallel with the tuning capacitance would almost certainly have a detrimental effect on the circuit being tuned. There are no significant losses through the resistor as the varicap does not conduct and only minute leakage currents flow through these two components.

The varicap must be connected to the main circuit via a d.c. blocking capacitor to ensure that the tuning voltage is not affected by d.c. potentials in the main circuit.

A MVAM115 varicap is used in the receiver described here, and the voltage versus capacitance graph for this device is shown in Fig. 2.

CIRCUIT DESCRIPTION

The complete circuit diagram of the Varicap Medium Wave Radio is shown in Fig. 3.

The receiver is quite conventional apart from the method of tuning, and utilises the well known ZN414 i.c. Resistor R6 biases IC1 via the ferrite aerial coil, L1.

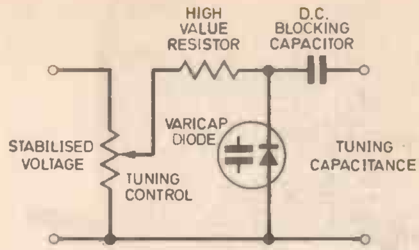


Fig. 1. Basic circuit for using a varicap diode.

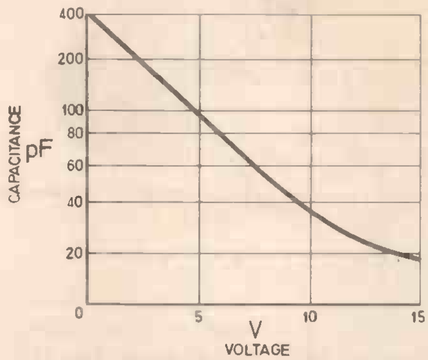


Fig. 2. Graph showing how the capacitance varies with applied voltage.

Capacitor C6 provides an r.f. path to earth for the "earthy" end of L1.

The ZN414 provides an a.g.c. (automatic gain control) action as well as r.f. amplification and demodulation. Capacitor C8 provides r.f. filtering at the output of the device and the audio output signal is developed across R8.

A supply potential of about 1·3 volts is required for the ZN414 circuitry, and this is obtained from the main 9 volt supply via the simple shunt stabiliser circuit which is comprised of R7, D5, D6, and C10. Diodes D5 and D6 are forward biased silicon diodes which each produce a voltage drop of about 0·65 volts, giving the required 1·3 volts in total.

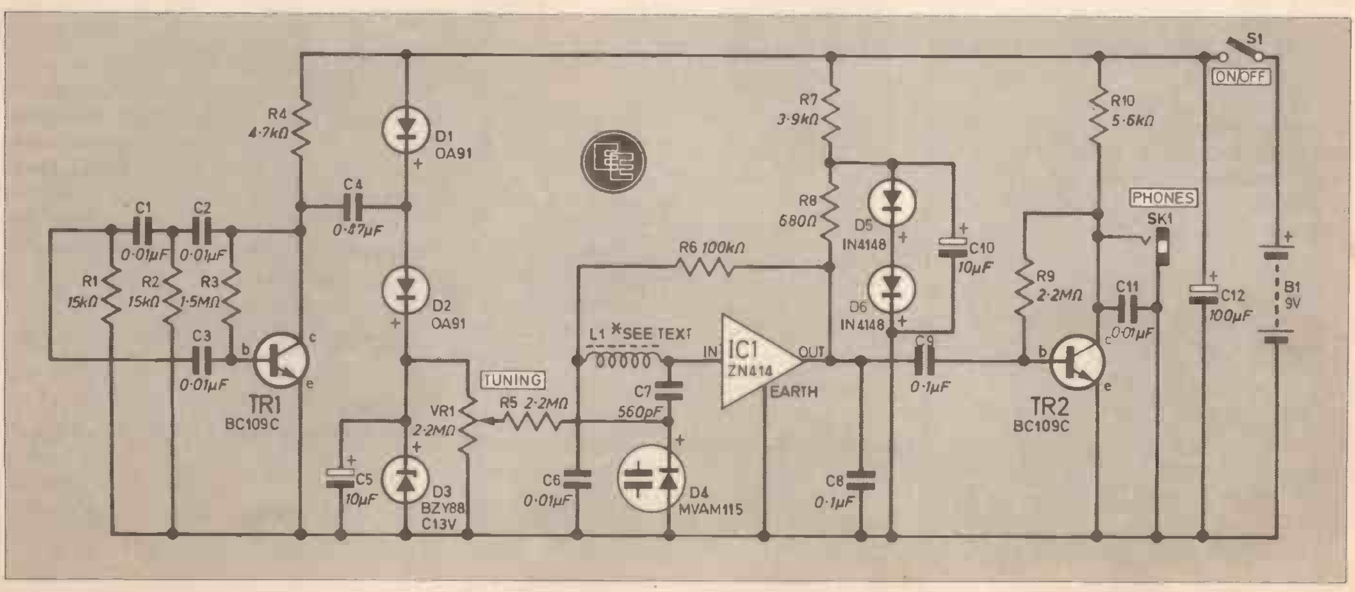
The audio output from IC1 is fed to a straight forward high gain common emitter amplifier, TR2. The earpiece is driven direct from the collector of TR2, and no d.c. blocking capacitor is required for a crystal earpiece (*other types are unsuitable for use with this set*). Capacitor C11 provides r.f. filtering at the output and helps to prevent instability from developing.

TUNING CIRCUIT

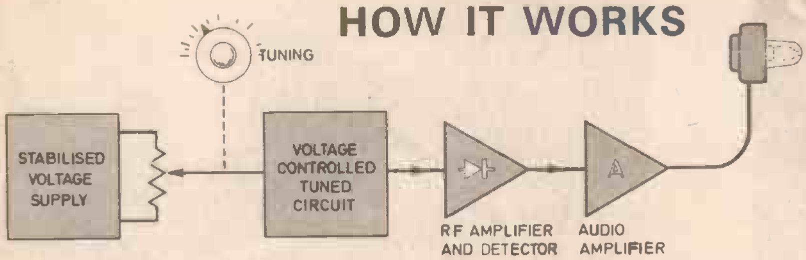
The varicap tuning circuit is along precisely the same lines as Fig. 1, as should be apparent from reference to the two diagrams concerned. The only point which requires any further amplification is the tuning voltage source.

The highest stablised voltage which can be obtained direct from a 9 volt battery is about 7·5 volts, and a level of 6·8 volts is preferable as it will give better regulation and longer battery life. Unfortunately, such a voltage would not give a very high maximum to minimum capacitance ratio from a MVAM115 varicap, and although coverage of the m.w. band would be possible, this would be less than optimum conditions, and would leave no margin for error in the winding of the aerial coil, etc.

Fig. 3. Complete circuit diagram for the Varicap Medium Wave Radio.



HOW IT WORKS



By means of an audio oscillator a stabilised voltage is generated which is higher than the normal supply. A proportion of this voltage is tapped off by the *tuning control* and applied to a *voltage controlled tuned circuit*. This part of the circuit contains rather a special device—a varicap diode. This device is able to alter its capacitance with voltage, thus varying a tuned circuit. The remainder of the circuit is conventional, changing the received radio frequency selected by the *tuned circuit* into audio, which is then applied to the earpiece.

OSCILLATOR

It is therefore preferably to step up the 9 volt supply to enable a higher tuning voltage to be obtained. In this case a potential of 13 volts is used, and this provides a swing of approximately 25 to 400pF across the varicap, which is more than adequate.

The step-up in voltage is obtained by rectifying and smoothing the output from an a.f. oscillator. The oscillator uses TR1 in a conventional phase shift oscillator configuration. This oscillates sufficiently violently to produce a high output voltage swing provided the output is only lightly loaded, but does not oscillate so violently as to produce high frequencies which would cause radio interference, as would an astable multivibrator.

Capacitor C4 couples the output from the oscillator to the rectifier and smoothing circuit which consists of D1, D2, and C5. This produces an output voltage of about 9 volts positive with respect to the positive supply rail, or 18 volts with respect to the negative supply rail. Zener diode D3 clips and stabilises the tuning voltage at a level of 13 volts.

Capacitor C12 is a supply decoupling capacitor and is mainly needed to prevent the a.f. signal from TR1 being fed to the rest of the circuit and being audible in the earphone. The current consumption of the receiver is only about 3·5mA which results in the PP3 battery supply having an extremely long life.

COMPONENTS

Resistors
- R1 15kΩ
- R2 15kΩ
- R3 1·5MΩ
- R4 4·7kΩ
- R5 2·2MΩ
- R6 100kΩ
- R7 3·9kΩ
- R8 680Ω
- R9 2·2MΩ
- R10 5·6kΩ

All ¼W carbon ± 10%

Potentiometer
- VR1 2·2MΩ carbon lin.

Semiconductors
- TR1 BC109C silicon *npn*
- TR2 BC109C silicon *npn*
- IC1 ZN414 t.r.f. radio i.c.
- D1 OA91 germanium
- D2 OA91 germanium
- D3 BZY88C13V 13V 400mW Zener diode
- D4 MVAM115 varicap diode
- D5 1N4148 silicon
- D6 1N4148 silicon

Capacitors
- C1 0·01μF polyester
- C2 0·01μF polyester
- C3 0·01μF polyester
- C4 0·47μF polyester
- C5 10μF 10V elect.
- C6 0·01μF polyester
- C7 560pF ceramic plate
- C8 0·1μF polyester
- C9 0·1μF polyester
- C10 10μF 10V elect.
- C11 0·01μF polyester
- C12 100μF 10V elect.

See Shop Talk page 590

Miscellaneous
- S1 miniature single pole toggle
- B1 9V PP3 battery
- SK1 3·5mm jack socket
- L1 75 turns 32 s.w.g. enamelled copper wire on ferrite rod (see text)
- Stripboard 0·1 inch matrix 15 strips by 37 holes; Verobox or similar case about 120 × 65 × 40mm; ferrite rod 75 × 9·5mm; 32 s.w.g. enamelled copper wire; PP3 battery connector; crystal earpiece with 3·5mm plug; large round knob; connecting wire.

CONSTRUCTION starts here

FERRITE AERIAL

The ferrite aerial, L1 is home made and constructional details are provided in Fig. 4. A ferrite rod measuring 75×9·5mm is required, and it is unlikely that a rod of this length is available. This makes it necessary to cut down a longer rod to the required length.

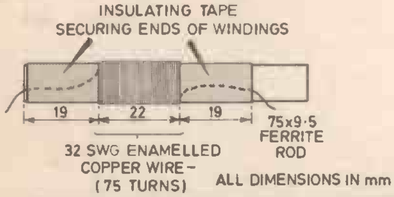
Ferrite is very hard and cannot be cut right through using a hacksaw. However, if a fairly deep groove is cut right around the rod at the point where it is to be severed, as ferrite is a very brittle material it will then be possible to simply snap the rod in two. It is recommended that an old hacksaw blade is used while this grove is cut as the blade is likely to be severely blunted.

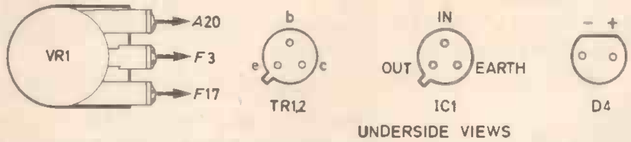
About 3 metres of 0·28mm diameter (or 32s.w.g.) enamelled copper wire are required for the aerial coil. Start by taping the wire to one end of the rod using 19mm wide insulation tape and leaving a leadout wire about 100mm long. Then neatly wind 75 turns of wire around the rod with the turns closely spaced.

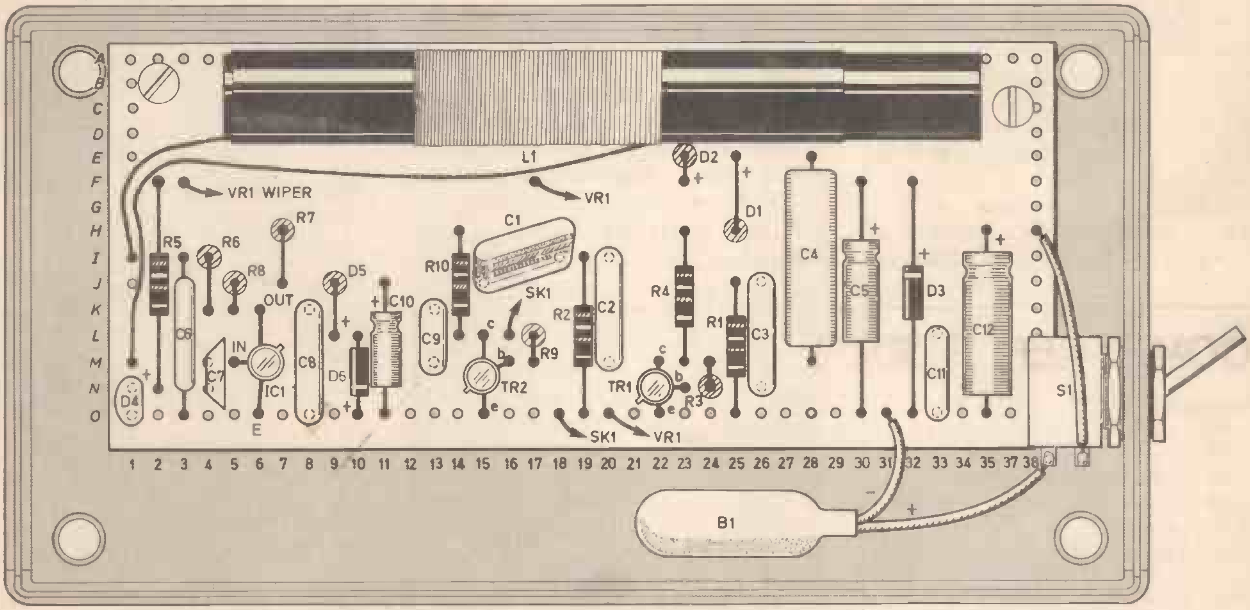
Finally, use another band of insulation tape to bind the free end of the wire to the rod, and then cut the remaining wire to leave a second leadout wire about 100mm long. The ends of the lead-

VARICAP MW RADIO

The Varicap M. W. Radio with front panel removed.







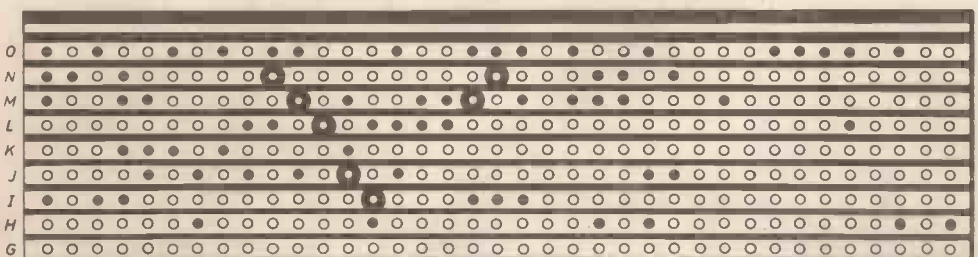
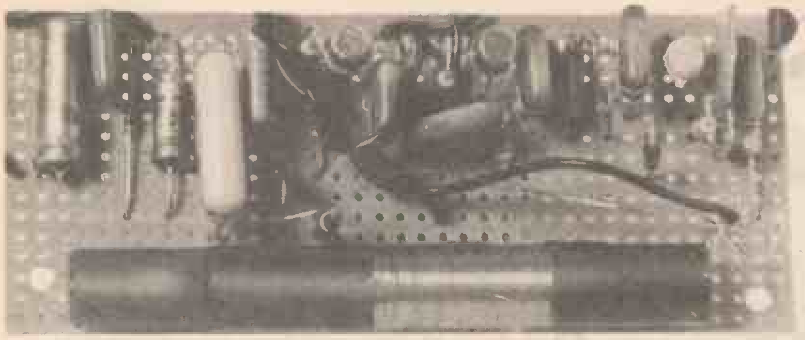


Fig. 4. Complete constructional details for the receiver. At top left is shown details for making the ferrite aerial. It is advisable to follow exactly the layout given here to prevent instability problems. Be careful when soldering in the varicap diode and the i.c.—both are sensitive to heat.



The completed circuit board for the Varicap Radio. The varicap diode can be seen in the top right corner.

out wires must be stripped of insulation and tinned with solder before they can be wired into circuit.

COMPONENT BOARD

Apart from the controls and battery, all the components are mounted on a 0·1inch matrix stripboard which has 15 copper strips by 37 holes. Commence by cutting a suitable piece of stripboard to the correct size using a hacksaw and then clean up any rough edges using a small file.

The two 3·2mm diameter mounting holes should be drilled in the board and the breaks in the copper strips made, see Fig. 4. Next the ferrite aerial is glued in position using a generous amount of epoxy adhesive, or some similar high quality adhesive.

The various components can now be soldered into position with the semiconductors being left until last. Be careful not to overheat diodes D1 and D2 when they are being soldered into circuit as these are germanium types, and are more easily damaged by overheating than the other devices used in the receiver.

A Verobox is used as the housing for the prototype, but any similar *non*-metallic case should also be suitable. The general layout of the unit can be seen from the photographs and it is advisable to follow this layout carefully as otherwise it is quite possible that difficulty will be experienced in fitting all the parts into the case.

FRONT PANEL

The tuning control, VR1 requires a 10mm diameter mounting hole and is mounted about 23mm to right of centre on the front panel. SK1 is a 3·5mm jack socket which is mounted low down on the left hand side of the front panel. The usual open construction sockets of this type require a 6·5mm diameter mounting hole.

The on/off switch, S1 is mounted a little below centre on the right hand side of the case, and the size of the required mounting hole will depend upon the make and type of switch used. Note that this must be a miniature switch if it is to fit into the available space.

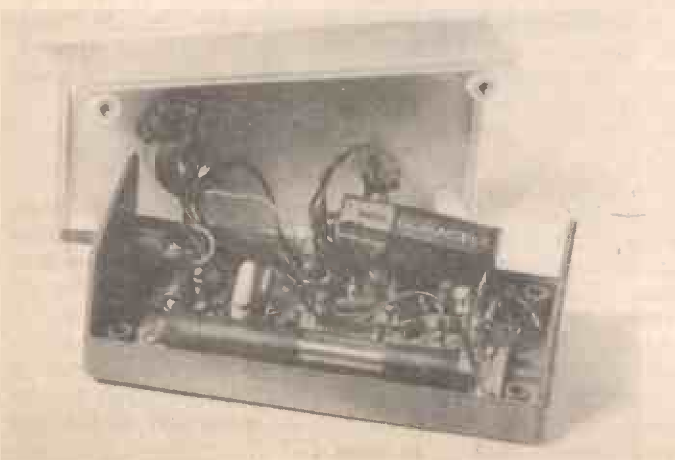
When the component panel has been competed and the controls and output socket have been mounted, the remaining wiring can be completed. This is all illustrated in Fig. 4. Multistrand p.v.c. insulated wires about 100mm long are used to connect the controls and SK1 to the component panel.

The Verobox has threaded mounting holes in the rear section, and the component board is mounted on the set of these at the top of the case using short M3 mounting screws. With other cases short M3 or 6BA mounting bolts with nuts can be used to hold the board in position. The PP3 battery fits into the space at the bottom of the case.

IN USE

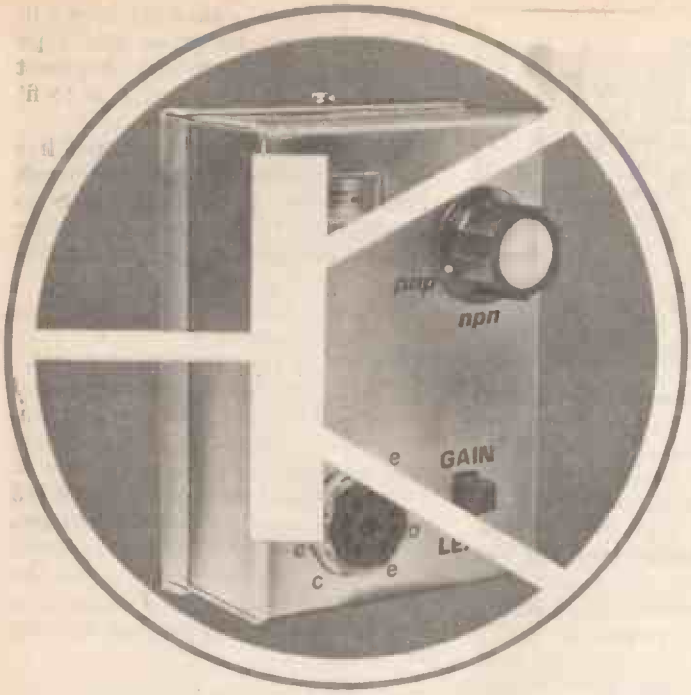
It is not necessary to align or adjust the finished receiver in any way, and it is ready for immediate use. The unit will provide good reception of the usual BBC m.w. stations, and a few foreign stations as well after dark.

One advantage of the varicap tuning is that the cramped tuning which usually occurs at the high frequency end of the band is absent. This is because at the low capacitance end of its characteristic the MVAM115 diode produces only a relatively small capacitance swing for a given voltage change, as can be seen by referring back to Fig. 1. This provides a sort of bandspread effect at the high frequency end of the band. ⌘



The completed radio with cover removed showing rough positioning of battery and board.

The finished Varicap Radio showing front panel tuning control and an earpiece plugged into the set.



Simple Transistor Tester

By D. J. Edwards

When you are taking your first tentative steps in the exciting field of electronics there can be many pitfalls and experience is hard won.

The first thing the serious amateur should equip himself with is test gear. This need not be expensive or complicated equipment, but can be extremely useful and instructive in guiding you through the snags that dog most early attempts at electronic construction.

GO/NO-GO TESTER

A multimeter must be the first priority in this respect, followed by capacitance and transistor testers. It is unrealistic to attempt to build your own multimeter and there are many designs for simple capacitance testers, but there seems to be a vacancy to be filled for a simple *GO/NO-GO* type transistor tester.

There are many designs for transistor testers which can accurately portray the various parameters of transistors, and while these are undoubtedly excellent pieces of equipment they are somewhat expensive and complicated for the amateur, providing a vast array of functions, many of which are of no use to the beginner.

The circuit to be described will allow the simple test of transistors for gain and leakage and could be used to determine whether they are *npn or pnp* devices by means of the polarity switch, the position for maximum gain indicating type.

GAIN AND LEAKAGE

To find out if a transistor is working, you have to test two things, its *gain* and its *leakage*.

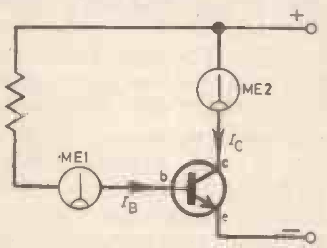


Fig. 1. Measuring the gain of a transistor.

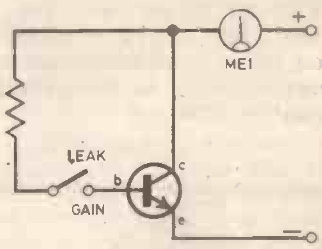


Fig. 2. Measuring the leakage of a transistor.

The gain of a transistor is a figure indicating by how many times the transistor amplifies current. The gain is found by applying a known current to the base and measuring current through the collector/emitter circuit (Fig. 1).

The transistor acts quite simply as a variable resistor, the amount of resistance between emitter and collector depending on the current flowing into the base. The larger this current, the lower the resistance of the transistor and consequently more current flows between collector and emitter.

Obviously therefore, for a given base current the collector current depends on the d.c. current gain (h_{FE}) of the transistor. The lower this figure, the smaller the current flow. For our purposes, however, it is sufficient to know that a current injected into the base will cause collector current to flow.

Leakage is quite simply the current which flows between the collector and emitter of the transistor when the base is left "floating" (Fig. 2). How much current "leaks" depends upon the inherent resistance of the transistor.

REVERSAL SWITCH

These two tests give us the basis for a transistor tester for *npn* transistors. To test *pnp* transistors as well, we must add a polarity reversal switch and this gives us our final circuit (Fig. 3). The inclusion of R2 is simply to provide some degree of protection to the meter if the transistor under test is short circuit.

CONSTRUCTION starts here

The construction of the author's unit can be seen in Fig. 4 but the layout is by no means critical. No circuit board is used as there are so few components and the components themselves can often be salvaged from scrap equipment.

VALVE SOCKET

The transistor test socket, it may be noted, is a nine-pin valve socket as opposed to the usual three-pin transistor socket. If it is wired up as shown this will provide facilities to test all the various types of transistor without having to twist their leads to fit a three-pin socket. It will also accept the Mullard range of Lockfit transistors such as BC148 and BF194 for example.

METER

Turning to the meter, it will be seen that this can be chosen from a wide range of moving coil instruments. A full-scale deflection (f.s.d.) of 200μA to 10mA is quoted, but this needs some clarification.

For testing silicon transistors, which are almost universally used nowadays, this range is fine. Silicon transistors have extremely low leakage (fractions of a μA) and should not register at all, whatever sensitivity meter is chosen.

COMPONENTS approximate cost £2.80

If you intend to test germanium transistors as well though, their leakage is usually a few hundred μA and if you're using a meter with a f.s.d. of 1mA or less this can cause confusion between leakage and gain readings.

The author's unit in fact uses a tape recorder level meter with a f.s.d. of about 200μA; but after deciding that it would be an advantage to test germanium transistors also, this meter was shunted by a

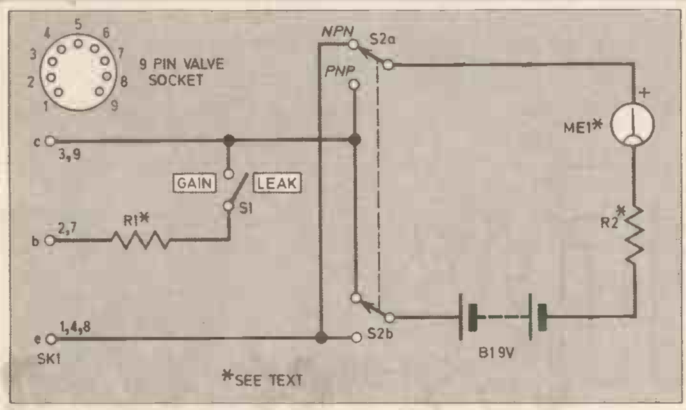


Fig. 3. The final circuit diagram for the Simple Transistor Tester.

Note that this circuit arrangement differs from that in Figs. 1 and 2. The meter is connected in the emitter circuit and so reads (Ic+Ib) which is of little consequence.

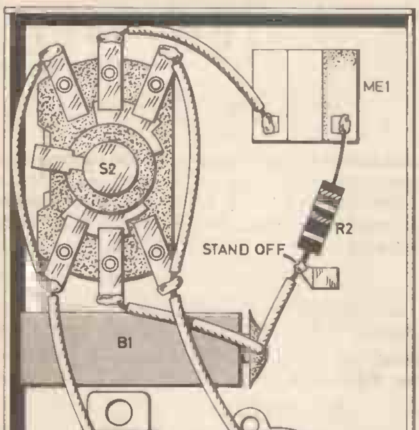


Fig. 4. The layout and interwiring of the components in the case.

COMPONENTS

Resistors

R1 820kΩ } see text
R2 3·3kΩ }

Miscellaneous

- S1 Single-pole single-throw switch
- S2 Double - pole double - throw switch
- M1 Moving coil meter 200μA to 10mA f.s.d. (see text).
- SK1 Nine-pin valve socket
- B1 9V PP3 battery

Battery connector. Aluminium box 102 × 70 × 38mm approx., (AB3). Stand-off anchor tag. Knob for S2.

The completed prototype tester showing positioning of components. A shunt resistor is shown connected across the meter terminals (see text).

resistor connected across it to decrease the sensitivity to about 2mA.

RESISTOR SELECTION

After selecting your meter, the next thing to do is select R1 and R2.

To select R2 simply connect the meter in series with the battery and a 50 kilohm variable resistor. Set the latter to maximum resistance and then reduce its resistance gradually until the meter gives full scale deflection. Measure the resistance on a multimeter, subtract 20 per cent from this figure and replace the variable resistor with a final resistor having the nearest preferred value. This resistor, while offering some protection to the meter, will also allow the battery to continue being used towards the end of its life.

To select R1 (which must be selected after R2 has been installed) wire in its place a 2 megohm variable resistor, and insert a high gain transistor (such as BC109 min. h_{FE} 180) into the socket. With the function switch set to GAIN, the variable resistor is turned until a nearly full-scale reading is obtained on the meter. The resistance is noted at this point and the nearest preferred resistor is insalled.

This completes the construction of the tester.

USING THE TESTER

Apart from testing transistors and identifying polarity, the tester can in its present form give an indication of the h_{FE} of unmarked transistors by comparison with known specimens.

By stabilising the supply voltage, installing a larger meter and applying a known current to the base, the gain could be read directly off the meter for more demanding purposes.

There are many cheap transistors to be had from bargain packs and scrap boards and this tester will help sort out the duds. And finally, it is a wise constructor who checks his components before he uses them in a circuit. ⌑

The finished unit showing front panel layout

ANTEX Competition RESULT

In our April issue we featured a competition in which entrants were asked to place eight aspects of soldering in order of importance in getting the very best results.

Having considered all entries, the judges decided the best received were a small number of identical attempts listing the following selection:

1st—E; 2nd—C; 3rd—A; 4th—K; 5th—J; 6th—B; 7th—D; 8th—L.

First Prize

Senders of this selection then took part in an eliminating contest to determine the winner of the first prize . . . which goes to Mr. John Slater of Sheffield. Mr. Slater wins a special **Antex Soldering Kit**—comprising two soldering irons, two stands, six iron-coated bits, solder and a heatsink.

Second Prize

The following six second prize winners are each awarded their choice between an **Antex CX** or **X25** soldering iron, *plus* a stand:

R. Hanson, Huddersfield, F. Haydon, Maidstone, J. McDonnell, Hockley, M. Osborne, Flitton, A. Rae, Aberdeen, A. Wildgoose, Leeds.

Runners-up

A similar choice of soldering iron goes to each of these 18 runners-up:

B. Carey, Bexhill-on-Sea, V. Clarke, Peterborough, B. Coggins, Melksham, K. Devereux, Hitchin, H. Evardson, Cleethorpes, B. Flatters, Thurlby, R. Foster, Halifax, C. Handley, Birkenhead, P. Moyes, Enderby, K. Oldham, Hyde, G. Parker, Ware, C. Pepper, Stoke-on-Trent, D. Rose, Dawlish, A. Rushworth, East Molesey, A. Stansfield, Todmorden, J. Stone, Wordsley, D. Thomas, Porthcawl, K. Welsh, Macclesfield.

mini~MODULES

By George Hylton

Handy "Beginner" projects based on simple circuits and featuring a variety of building methods.

LOW POWER AUDIO AMPLIFIER 11

This month's design is a low-power audio amplifier for 9-volt operation. In designing it the main aims were low quiescent consumption and the ability to accept a wide range of loudspeaker impedances.

The Mini Amplifier will work into loads of 3 ohms upwards, which means that almost any ordinary loudspeaker can be connected. The output power varies from about 100mW to 1W, depending on the loudspeaker impedance and (to a limited extent) on the current gains of the output transistors.

The quiescent current (that is, the standby current drawn when there is no input signal) is typically about 5mA. The audio input for full output is 100mV r.m.s. and the input impedance is high (about 400kilohms). This enables the amplifier to be driven by a wide variety of signal sources.

THE CIRCUIT

After pondering over the requirements I eventually opted for a rather old-fashioned design (Fig. 1). This consists of an input stage (TR1) followed by a two-stage power amplifier (TR2-TR5). Only TR2, TR4 and TR5 play an active role. TR3 is merely a biasing device to ensure that the output transistors (TR4 and TR5) operate with the correct quiescent current.

In order to economise in current the output pair (TR4, TR5) are biased so that they just conduct when there is no input signal, passing around 1mA only. The principal consumer of current is then TR2, the driver, which passes around 4mA.

This is rather a small driver current and it means that the peak drive to TR4 and TR5 is only about 4mA. If their current gains are 100 (a typical value) their peak output to the loudspeaker cannot exceed 400mA. This is enough to drive a 10-ohm load (the speaker) to maximum possible output for this type of circuit, but not enough to produce maximum possible output with loads of lower impedance.

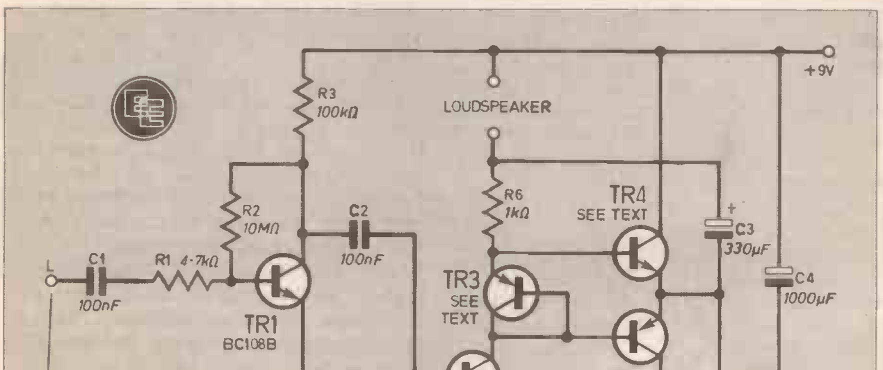
SAFETY PRECAUTION

Thus the power output to a low-impedance speaker is limited because TR4 and TR5 are under-driven. This is a safety precaution intended to limit the strain on the output transistors when a low-impedance speaker is connected.

However, if the gain of the output pair (h_{FE}) is more than 100 then loads of less than 10 ohms can be fully driven and maximum output occurs at some other load impedance.

With the prototype amplifier, the output for loads of 4 to 5 ohms peaked at about 1·2W; for fully driven output transistors it would have been around 2W. (The theoretical output power in watts for this particular circuit is roughly 8 divided by the load impedance; thus a 16-ohm speaker should receive about half a watt.

Fig. 1. Circuit diagram for the Low Power Audio Amplifier.



CHOICE OF TRANSISTORS

The output stage is designed for germanium transistors. As these are not now as easy to obtain as they once were I'll mention a number of possible alternatives.

Two sets were tried out in the prototype. These were the European types AC187 (TR4) and AC188 (TR5) which are still obtainable in complementary matched pairs. The second pair were the Japanese 2SD72 (TR4) and 2SB405 (TR5), which gave similar results.

American types which should work are 2N1306/2N1307 and 2N1308/2N1309. Other possible European types are AC127/AC128, AC127/AC152, AC176/AC153. If these cannot be obtained you can always use the ubiquitous AD161/AD162; these are proper power transistors in metal cases and in this circuit they are under-run and should not need a heat sink.

COOLING CLIPS

All the others are small transistors worked hard and good cooling clips are essential.

These transistors begin to conduct with about 100mV applied between base and emitter. This then is the correct bias for setting the quiescent current, except that since the two base-emitter junctions are in series across the bias source the bias voltage has to be doubled to 200mV for the pair.

This 200mV must be stable against current changes and should fall as the ambient temperature rises to give a measure of thermal stabilisation.

The answer is to derive the bias from a semiconductor. I found that almost any germanium *pnp* alloy transistor develops the right bias when connected as a "transistor diode"; i.e., with its collector connected to its base to form the diode cathode, and its emitter used as the anode.

In the prototype the "bias diode" was an OC81 but the following types were tried and found satisfactory: ACY27, AC188, GET113, GET872, OC45, OC71, OC76, OC81Z, and OC306, as well as some nameless germanium switching transistors salvaged from old "computer boards".

SETTING UP

The value given for R5 (220kilohm) is correct for an average driver transistor, which should be BC107B, BC108B or BC109B. The "B" signifies that the current gain is around 300. There is however some danger that 220kilohm may not be quite correct for your particular driver transistor because of the "spread" of current gain among different specimens of the same nominal type.

To check, measure the d.c. voltage between the emitters of the output pair and "earth" (battery negative). Do this with the loudspeaker connected or a 10 ohm resistor in its place. The voltage should be half the battery voltage. If it is out by more than half a volt full output power will not be obtained and a new R5 is advisable. To raise the measured voltage, increase R5 and vice versa.

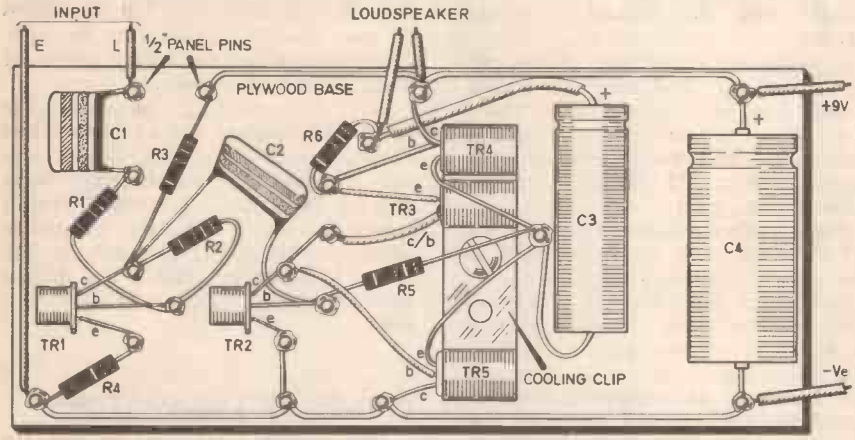


Fig. 2. Component layout on a plywood base.

CONSTRUCTION

The logical housing for the Mini Amplifier is inside the cabinet of whatever loudspeaker you use. For this reason no cabinet is specified here; but if you have a speaker but no cabinet it is easy to make one from wood.

The Mini Amplifier circuit itself can be assembled on a plywood base.

To suit my own loudspeaker cabinet I used a base measuring 105 x 48mm. This enabled the components to be arranged as in Fig. 3. For anchorage points I used half-inch panel pins of steel. The alternatives are brass ones (which take solder better) or plated domestic pins: the 15mm type known to stationers as Lills are very suitable.

To minimise the amount of heat to sensitive components connect and solder as you go, in this order: plain connections, resistors, capacitors and finally semiconductors. Remember that germanium semiconductors are particularly vulnerable to overheating.

Unless your loudspeaker has a very high impedance (for example 80 ohms) a large battery will be needed because the drain can be quite heavy. This is especially true when the amplifier is driven continuously by a steady signal such as the sine waves used in compiling Fig. 2.

For speech and music the demand is more intermittent but will still peak to the sort of values indicated during loud continuous passages. Remember to leave space inside your speaker cabinet for a PP9 or similar large 9V battery.

Because the power dissipated by the output transistors is comparatively high when a low-impedance loudspeaker is used some safety precautions are necessary when using loudspeakers of less than 10 ohms impedance.

The first is simply to restrict the input signals to speech and music, because these impose much less strain than continuous signals such as the output of an audio oscillator.

The second precaution is to fix TR3 so that it is in thermal contact with the output transistors so that if they get warm the bias transistor gets warm, too. Assuming that the output transistors are insulated from their cooling clips, the easiest way to ensure thermal contact is to cement TR3 to a cooling clip.

If you must use a low-impedance speaker with continuous signals then an extra precaution is needed: connect 3·3 ohms in each emitter lead of the output transistors, so that the output current passes through this on its way to or from C3. It is essential to use two separate resistors, one for TR4 and one for TR5, connected together at C3 only. Half-watt resistors are suitable.

VOLUME CONTROL

Although no volume control is included in the circuit it will generally be convenient to add one at the input and also to use a control with a combined on/off switch.

The slider is connected to C1, and the input across the full resistance track, one end of which is earthed. Any value of resistance may be used, but remember that the resistance falls across the input and therefore reduces the effective input impedance.

This may be no bad thing because high input impedances invite hum and can make screening necessary. Reducing the input impedance reduces the hum, at the price of loss of sensitivity for signals which come from high impedance sources. A good compromise value which preserves a reasonably high impedance is 47kilohms. A log. law potentiometer should be used.

COMPONENTS

Resistors

R1	4·7kΩ
R2	10MΩ
R3	100kΩ
R4	3·3kΩ
R5	220kΩ (See text)
R6	1kΩ

All carbon film, 5% or 10% ¼W

Capacitors

C1	100n (0·1μF) polyester
C2	100n (0·1μF) polyester
C3	220μF, 250μF, or 330μF 16V elect.
C4	1000μF 16V elect.

Semiconductors

TR1, 2 BC107B, BC108B or BC109B (2 off)
TR3, TR4, TR5 — See text

Miscellaneous

Small piece of plywood for base. ½-inch panel pins or 15mm household pins. Cooling clips for TR4, TR5 (Most transistors specified take "TO-1" clips). Volume control with on/off switch if required.

Next Month: Universal Oscillator.

DOING IT DIGITALLY

PART 12

By O. N. Bishop

IN THIS final part we develop a parallel adding circuit. We also look at ways in which TTL can be used in the measurement of continuously variable quantities, such as temperature, and design a practical digital thermometer.

PARALLEL ADDITION

Last month we used a one-digit adder, fed numbers into it one digit at a time, and recorded the sum a digit at a time. Readers probably found this serial addition a rather slow and tedious process and will be glad to hear that this month we are arranging for the i.c. to perform a larger share of the work.

The added i.c. used this month, is the 7483 (Fig. 12.1) which adds two four-digit numbers simultaneously and all the carrying over between digits takes place within the i.c.

One of the numbers to be added is made the input to pins A_1, A_2, A_3 and A_4, where A_1 is the least significant digit, and A_4 is the most significant digit. The other number is input to pins B_1, B_2, B_3 and B_4.

If there is any carry-in from some previous stage of addition, there is an input pin for this, but for the adding circuit described here we shall simply ground the carry-in.

The output from the i.c. gives the sum in digits S_1, S_2, S_3 and S_4, with any carry-out from m.s.d. appearing at C_4. We can consider C_4 to be a fifth digit (becoming the m.s.d. if used) which appears in such additions as 1101 + 1001 = 10110.

ADDING SYSTEM

The system for an adding circuit based on the 7483 is shown in Fig. 12.2a and wired up on the Test-Bed in Fig. 12.2b. The keyboard provides inputs to A_1-A_4, representing the first of the two numbers to be added.

Assuming that the flip-flops of the 7495 shift register (see last month's article) all have low output, the sum displayed is simply the number being held on the keyboard. Since we are working with all four digits at once, we are able to use the output from the adder as input to the 7447 i.c. of

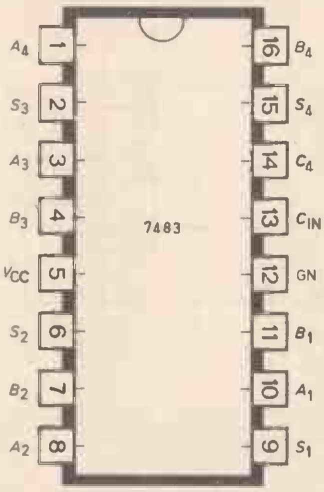
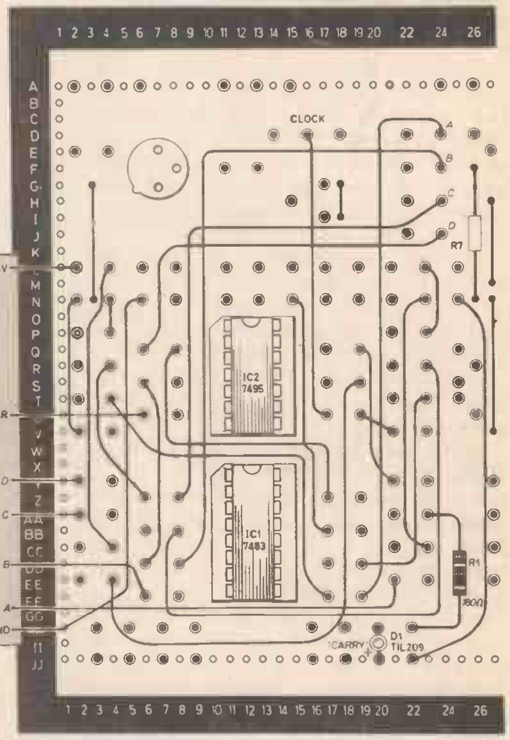
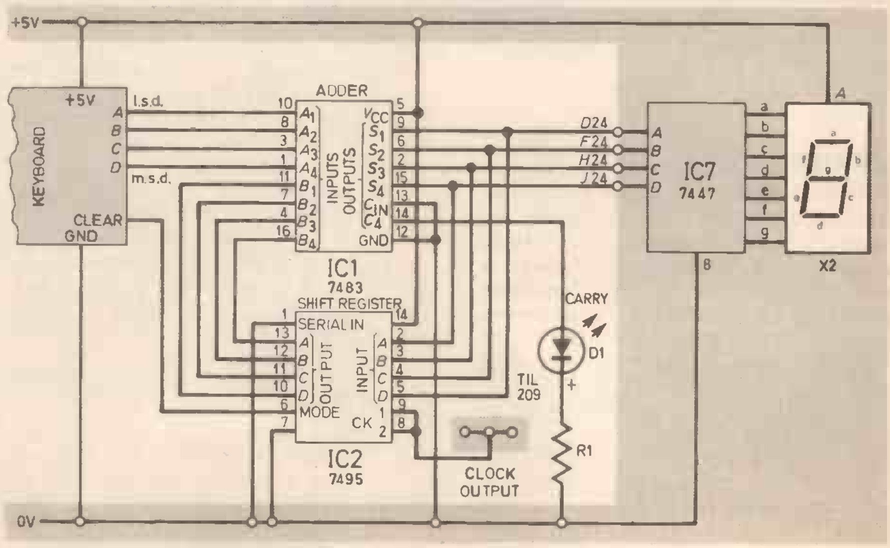


Fig. 12.1. Pinning details of the 7483 i.c.

Fig. 12.2a (below). System for adding two 4-digit binary numbers.

Fig. 12.2b (right). The circuit of Fig. 12.2a wired up on the Test-Bed.





one of the 7-segment displays of the Test-Bed. Use the right-hand display because this shows "0" when the input is 0000, whereas the left-hand display has zero-blanking and is totally blank when its input it 0000.

Since we wish to add a second number to the one that is being displayed, we must next store the first number. This is stored in the shift-register by parallel entry, in the same way that we used for loading the register last month. Mode control must be high.

In practice, the input to mode control is at this stage disconnected, so it is effectively high. As the clock goes low, the number becomes registered in the flip-flops. Their outputs are the same as the original inputs from the keyboard, and are now fed to the *B* inputs of the adder.

At this stage the adder is receiving the same number twice, through its *A* inputs *and* through its *B* inputs. The sum outputs are thus double the number originally keyed and the display shows this doubled number. This state is only temporary, for as soon as the key is released the *A* inputs of the adder become zero and the display reverts to the original number.

Having stored the first number and having this number at the *B* inputs, we now need only press another number key to input the second number to the adder. The sum of this and the first number now appears on the display. This must be done *before* the clock goes low again.

It is best to run the clock at its slowest speed but, if you prefer it, you can feed the clock output through the latch on the the Test-Bed and use the latch control switch to interrupt the train of pulses from clock while you add in the second number.

A simple key is *not* suitable for interrupting the clock output train, for a series of multiple makes and breaks (switch contact "bounce") causes great confusion—sums are loaded, applied to the *B* inputs, new sums obtained and loaded, and so on several times over. A clean-cut clock pulse is essential.

MAXIMUM SUM

With this adder the maximum sum obtainable is 9+9=18, and there are many additions which have sums greater than 9. The 7447 decoder is not designed to work for numbers greater than 9 and if the total comes to 10 or more the display shows one of the strange characters shown in Fig. 12.3.

If the total comes to 16 (10000 in binary) or more, the carry lamp lights and the display shows 0 (=16), 1 (=17) or 2 (=18). It is feasible to build an extra decoding circuit that takes over the decoding when the number is greater than 9, to display a 1 on the left-hand digit of the display, and to cause the correct digit to appear on the right-hand display. The decoding required only a handful of simple gates—the reader may like to try this as an exercise in logic design.

Fig. 12.3. The way numbers greater than 9 are displayed by the 7447 decoder i.c.

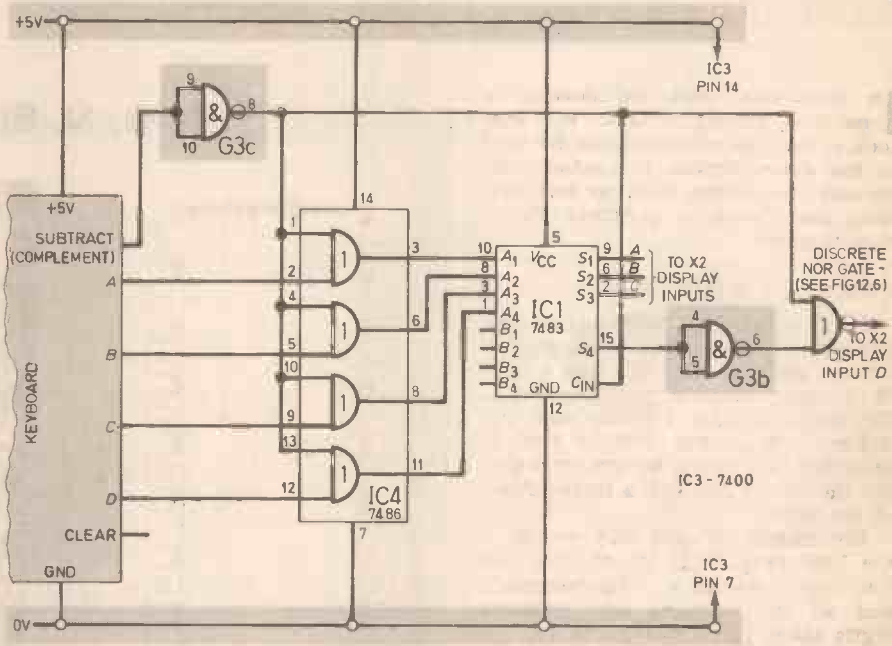


Fig. 12.4. Modification to adding circuit (Fig. 12.2a) to allow subtraction.

When addition is complete, the first number still remains on the shift register. The easiest way to remove this is to shift it out of the register. The serial input is grounded and, as the clock pulses arrive, the data is shifted out. It is replaced by zeros because serial input is permanently connected to ground. One of the spare keys can be used as a CLEAR key. Use the lower left-hand key, that was used last month as a SHIFT key. When pressed, this grounds mode control input, causing data to shift and the registers to be cleared in four clock pulses.

SUBTRACTION

As explained last month, binary subtraction can be done *by addition* if we first take the complement of the number to be subtracted, add this to the number from which it is to be subtracted, then add 1 and, finally, ignore the 1 that appears as the most significant digit. For example, to subtract 110 from 1101:

Complement of 110 is 001

other number	1101
+ complement	001
+ 1	1
Total	1111

Ignore the 1 on the left, leaving the answer to the subtraction, 111. In decimal, this is (13−6)=7.

To perform subtraction, the adding circuit is modified as in Fig. 12.4. The truth table for exclusive-OR is below.

Table 12.1. Exclusive-OR truth table.

Inputs *A*	Inputs *B*	Output *C*
0	0	0
0	1	1
1	0	1
1	1	0

Input *A* from the INVERT gate of IC3, is fed to all four exclusive-OR gates. The exclusive-OR output follows *B* if *A* is low, but is the inverse of *B* if *A* is high. If the output of the INVERT gate is low (its input is disconnected, effectively high) data from the keyboard is passed through to the *A* inputs of the adder unaltered.

Also carry-in is low. In this condition the operation of the circuit is unaffected by the modification. But if we ground the input to the INVERT gate, its output goes high. This makes the exclusive-OR gates pass inverted data to the adder—the adder receives the complement of the number keyed. At the same time carry-in becomes high, which provides for the addition of 1, that this method of subtraction requires.

The routine for subtraction is to key the first number and wait for the clock to go low. This number is then stored in the register. Next key the number to be subtracted and *at the same* time ground the input to the INVERT gate. The top-left spare key (used last month as COMPLEMENT key) can be used for this. The complement of the second number will then be added to first number, and an extra 1 added in by way of the carry-in input. The display shows the answer, but unfortunately it does not ignore the first 1. So the result of a subtraction such as (1001−1000) is displayed as "9" (1001) when it should really be "1" (001). We need some way of applying a low *D* input to the display whenever the COMPLEMENT key is pressed, yet still allow the input to receive normal inputs at other times. A truth-table of the requirements is shown in Table 12.2.

Table 12.2. Required truth table for binary subtraction.

Function	Inputs: Output from INVERT	Inputs: D-digit from S_4	Output (Input to D of display)
During addition	0	0	0
	0	1	1
During subtraction	1	0	0
	1	1	0

Three lows and one high in the output column indicate that either a NOR or an AND is required, but a straightforward NOR of these two inputs would give 1 in the last line, not in the second line. If we invert the digit from S_4 before NORing it, we obtain the correct function. To invert the S_4 output we use the NAND gate of IC3.

DISCRETE GATE

There is no space left for a NOR i.c., so once again the best solution is to make up a gate from discrete components (Fig. 12.6), almost any *npn* transistor and any silicon diodes can be used. The *modifications* to the Test-Bed layout are shown in Fig. 12.7. Keyboard input now comes first to the 7486 and its former connections direct to the 7483 are removed. The grounding link to the carry-in of the 7483 (pin 11) is removed, as is the output

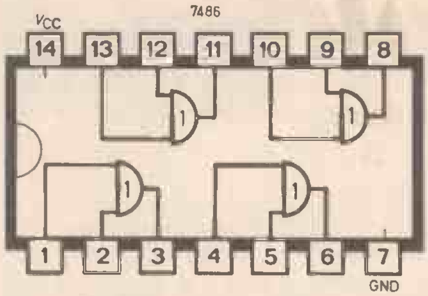


Fig. 12.5. Pinning details for the 7486 quadruple 2-input exclusive-OR gates.

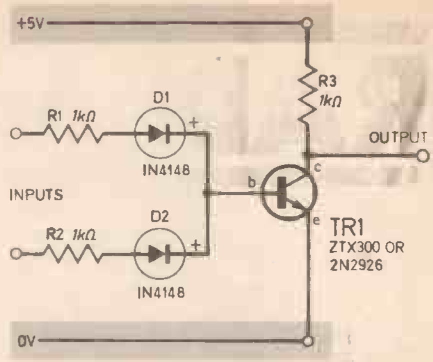


Fig. 12.6. NOR gate from discrete components.

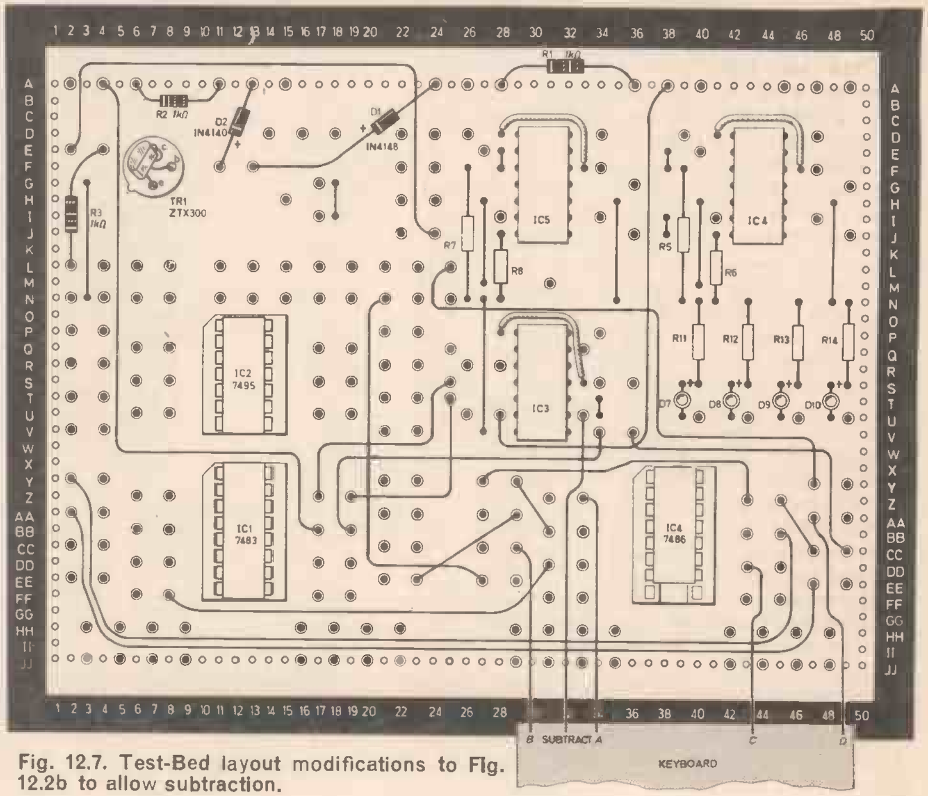


Fig. 12.7. Test-Bed layout modifications to Fig. 12.2b to allow subtraction.

from the 7483 to the display *D* input. The CLEAR input wire from keyboard remains unaltered, as do all other connections shown in Fig. 12.2b.

TTL AND ANALOGUE DATA

TTL deals with data in digital form, as its name indicates, but there are many occasions when it would be useful if it could deal with data that is not just ones and zeros but has continuously variable values.

Quantities such as light intensity, temperature, humidity, voltage, length and weight, can vary smoothly over a given range. We call these *analogue* quantities. If these quantities can be represented in some digital way, they can be dealt with by TTL. Nowadays even a complex variable such as the waveform of sound is being converted into digital form, giving digitally recorded discs and tapes that can be played back to give high fidelity sound. A similar process is being used in telecommunications.

DIGITAL THERMOMETER

As an example of analogue-to-digital conversion this series concludes with a circuit for a digital thermometer, that can be assembled on the Test-Bed and later built on a circuit-board as a permanent unit. The basic circuit is shown in Fig. 12.8a. The analogue-to-digital conversion takes place in the astable multivibrator, made from two NAND gates.

A thermistor (RTH1) is a piece of semiconductor material, which can be in the form of a bead, a bar or a disc. Its special property (in this case) is that its resistance decreases as temperature increases. The effect of

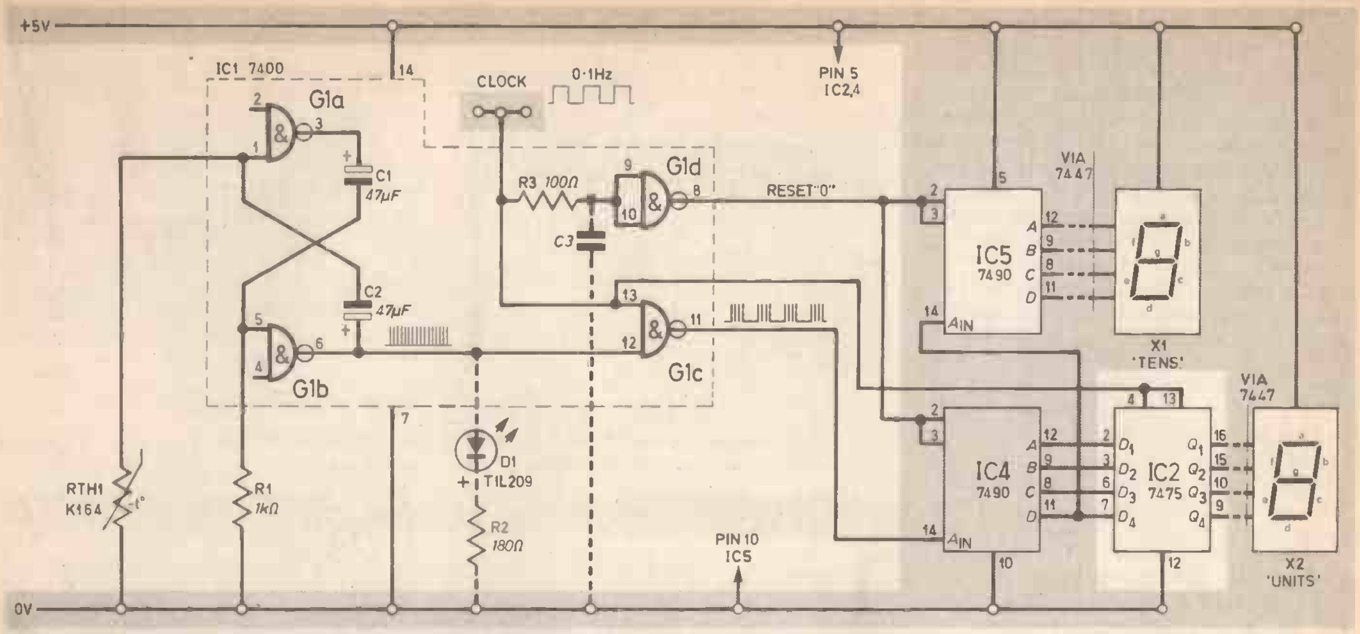


Fig. 12.8a. Circuit for a digital thermometer; D1 is optional but is useful for visualising the effects of varying temperature.

this is that the frequency of oscillation of the multivibrator increases as temperature increases. To put it another way, in a fixed period of time, the *number of pulses* generated by the multivibrator is proportional to temperature.

The relationship between temperature and number of pulses is not linear, but is sufficiently close to linear over the small temperature range for which this circuit is designed.

With the component values shown, the multivibrator produces about 45 pulses in five seconds when the temperature is 20 degrees Celsius. If the temperature falls to 10 degrees Celsius, the pulse number falls to 35 pulses in five seconds. The pulse number falls by 1 pulse for every one degree fall in temperature. Thus if we run the oscillator for five seconds and it gives 39 pulses we can deduce that the temperature is 14 degrees

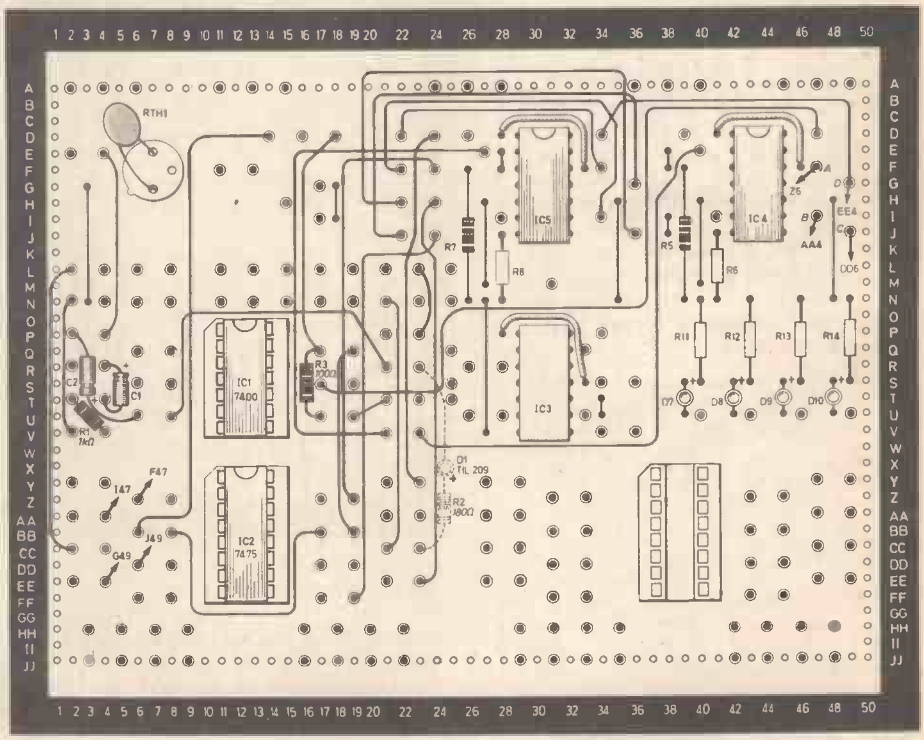


Fig. 12.8b. Layout for Fig. 12.8a on the Test-Bed.

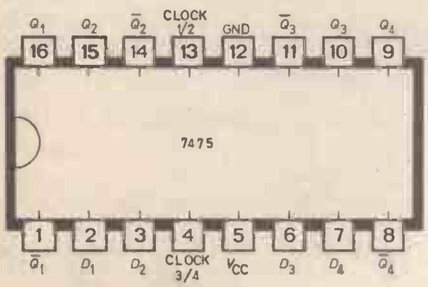


Fig. 12.9. Pin-out details for the 7475 i.c.

Celsius. This relationship applies within the 10 to 20 degrees Celsius range and a little outside it, so is very suitable for a domestic or greenhouse thermometer. A clock running at 0·1Hz (i.e. with a high period lasting five seconds) supplies the control signals.

When the clock is high, pulses can pass through the NAND gate (G1c) to IC4 and IC5, which are linked so as to count the number of pulses received. When the clock goes low, no more pulses are passed to the counters, and a high "reset" output is sent to the reset "0" inputs of the counters. The 100 ohm resistor delays this action very slightly. If this delay is not long enough, it can be lengthened by adding a capacitor, as indicated by dotted lines in Fig. 12.8a.

At each high pulse from the clock, the counters count the number of pulses received and are then reset to zero. A latch i.c. is employed to record the final count from IC4.

The 7475 (Fig. 12.9) contains four latches, each similar in function to the built-in latch of the Test-Bed. These latches are controlled by clock inputs, one controlling latches 1 and 2, the other controlling latches 3 and 4. All four latches are controlled together by joining the clock inputs.

When the clock inputs are high (during pulse counting) the data entering the latches appears at the Q outputs. As inputs change, outputs change accordingly. At the instant that the clock goes low, outputs are latched and hold the input data unchanged until clock goes high again. The $\bar{Q}$ outputs are the inverse of data, but we do not use these here.

The effect of the latch is to hold the maximum value reached by the units counter (IC4), so giving us five seconds to read the display while the clock is low. The delay resistor at G1d is to allow the latch to complete its action before the counter is reset and the count is lost.

Ideally there would be another 7475 to hold the "tens" count from IC5, but there is no room for this on the Test-Bed. Since the "tens" display changes fairly slowly it is not too difficult to tell what its maximum value was. Another suggestion on how to deal with this problem is given later.

SETTING UP

The initial layout on the Test-Bed is shown in Fig. 12.8b. The clock is used at its lowest frequency (0·1Hz) and if the room is at 20 degrees Celsius (68°F) the counters should record 45 pulses during each high pulse from the clock.

If you are banished to a cold attic for your favourite hobby, measure its temperature and work out what the count should be—add 25 to the temperature in degrees Celsius. If the number of pulses is incorrect, adjust the frequency of the multivibrator. For large changes alter the capacitors, for smaller changes replace the 1 kilohm resistor for one of different value. Check that the room temperature has not altered significantly during the test runs.

As a final check, immerse the thermistor in water at various temperatures. For this purpose, as well as for final use, the thermistor may be attached to a long lead without affecting the calibration. Thus it can be used for remote-reading. The thermistor could be in the greenhouse with the circuit and display indoors.

SCALE CONVERSION

The pulse count is equal to the temperature plus 25. The reader might wonder why we do not make the multivibrator oscillate more slowly, so as to give 20 pulses at 20 degrees Celsius. This could easily be done, but then we find that it gives 15 or 16 pulses at 10 degrees Celsius, so calculation is no easier and precision is much less. We therefore need to subtract 25 from the number of pulses by cancelling the first 25 pulses that are counted. In other words we

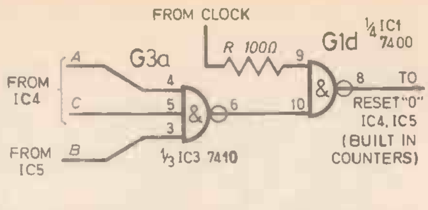


Fig. 12.10a. Modifying the digital thermometer to reset the counters after 25 pulses.

reset the counters when they get to 25. The modification for doing this is shown in Fig. 12.10b.

When 0010 0101 (=25) appears on the counters the output of G3a goes low; clock is high at that stage so G1d goes high, resetting the counters. This makes low all the inputs to G3a and counting resumes from zero.

If on the rare occasions that we have a heat-wave and the thermometer displays a near-freezing temperature such as 4 degrees Celsius, it is obvious that the counters have been to 25 twice, so that 50 pulses have been subtracted. The actual temperature would be 25 degrees higher—that is 29 degrees Celsius. With this simple circuit we cannot cope with heat-waves.

In operation the display flickers rapidly for five seconds, during which it counts up to 25, is reset back to zero and then counts up to its final count. The numbers change too rapidly to be read. After this the display shows the temperature in degrees Celsius for five seconds. Then it repeats the whole sequence for as long as it is switched on.

If you find it hard to read the "tens" digit because of the lack of a latch on this display, you could rely on the fact that indoor temperatures are most likely to stay in the range 10 to 19 degrees Celsius, so that the "tens" digit is nearly always 1. Disconnect IC5 from the display inputs and wire the "tens" display to show "1" permanently. Simply ground pins B, C, and D, and connect pin A to V_{cc}.

PERMANENT UNIT

A permanent unit could use a 555 timer i.c. to provide the clock pulses. By suitable choice of time resistors the high period could be made very short—a few hundredths of a second. The capacitor values of the temperature-controlled multivibrator would then have to be reduced considerably, so that we still obtained 45 pulses during the high period (at 20 degrees Celsius).

A variable resistor would help set the timer so as to be high for exactly 45 pulses. Then the flicker effect would be almost imperceptible, being so short, and the display would appear to shine unchangingly, except when the temperature itself changed. Alternatively, for economy, the clock could be built from the two spare gates of the 7410. An additional 7475 would be desirable so that the "tens" count could be displayed.

MORE ANALOGUE CONVERSIONS

The previous circuit can be modified to record other types of analogue data. The thermistor can be replaced by a light dependent resistor to make a digital light meter, that displays light intensity on some arbitrary scale.

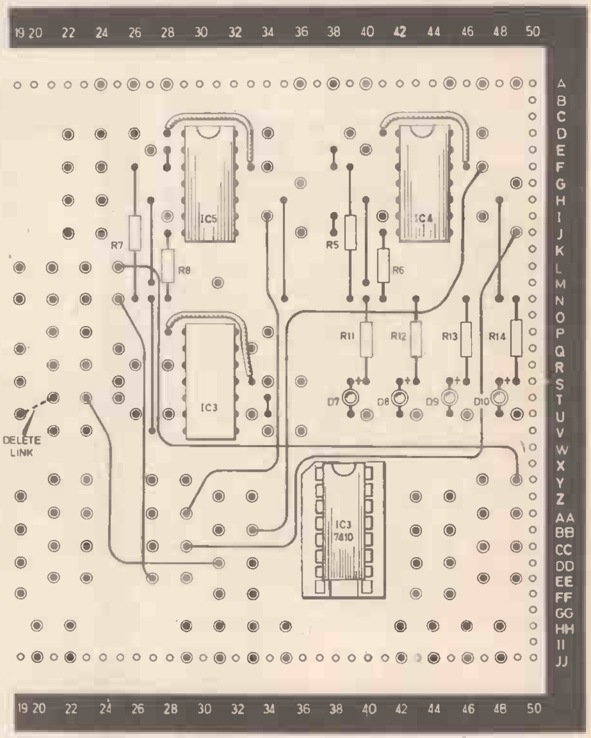


Fig. 12.10b. Additional wiring (and removal) to layout of Fig. 12.8b to incorporate circuit of Fig. 12.10a.

By replacing the thermistor by two metal prongs a few millimetres apart it could be used to measure and display a value for soil moisture content, again on an arbitrary scale.

The design problems are *yours*, for the purpose of this series is to leave the reader with the Test-Bed and an assortment of i.c.s and other components that can be used over and over again for TTL designed projects.

It is hoped that the topics that have been dealt with here, even though some of them have only been briefly touched upon, will have given you some insight into the possibilities of TTL and the enthusiasm to try your hand at *Doing It Digitally*. ☐

ee70 reflex LOUDSPEAKER

By R. F. STEPHENS

IN the July issue we described the construction of an inexpensive loudspeaker compatible with the EVERYDAY ELECTRONICS 2020 Tuner Amplifier.

In order to cover the most exacting requirement of audiophiles this month a much more sophisticated (and more expensive!) loudspeaker design capable of a very high standard of sound reproduction is presented. It is also, the author believes, the first d.i.y. hi fi design of this kind to utilise a piezo electric treble unit.

POWER CAPABILITY

The EE70 loudspeaker system will handle a 70 watt r.m.s. continuous signal. This means, in practice, it is suitable for use with amplifiers delivering from 20 to 100 watts per channel and can be driven by the EE 2020 tuner amplifier.

The enclosure is fairly large—over 60 litres capacity—and is a reflex design using a 12 inch bass unit with Bextrene cone. The bass drive unit is the Dalesford D100/310, one of the smoothest bass units currently available and used in a number of "monitor" quality designs. The midrange unit is from the same manufacturer and is the model D50/153, a $6^1{}_2$ inch Bextrene-coned unit which appears as the bass/midrange unit in several manufacturers' compact designs. The third drive unit is a Motorola piezo electric tweeter.

SPECIFICATION

Three-way bass reflex enclosure: dimensions 640 × 380 × 355mm

Drive units: 12 inch bass, 6½ inch mid range, 6×2 inch horn treble tweeter

Frequency range: ±3dB 30Hz to 20kHz

Crossover frequencies: 500Hz; 3,000 Hz

Impedance: 8 ohms

Recommended amplifier output: 20 to 100 watts per channel

PIEZO ELECTRIC TWEETER

Many readers may not be familiar with the piezo electric tweeter so a few words on this might not go amiss:

Nearly everyone is aware of the piezo-electric phenomenon as exhibited by a ceramic pickup cartridge. Displacement of the stylus by modulation of the record groove acts upon a lever which distorts a piece of piezo electric material which then generates an audio signal suitable for driving the first stage of an amplifier.

This phenomenon is reversible—applying an audio signal across the piezo material will cause it to deform in accordance with the signal applied. This basic principle is used in the Motorola piezo tweeter.

Two thin slices of lead-zinconate-lead-titanate ceramic are bonded to a brass separator. These discs are polarised so that one expands whilst the other contracts when an electrical signal is applied. This causes a "dishing" in and out in response to the audio signal.

This transducer is made in several different forms, both direct radiating and horn-loaded. For this loudspeaker design, the horn-loaded version type KSN 6025A was chosen with a horn aperture of 2 inch×6 inch.

The piezo electric driver offers certain basic advantages over tweeters of conventional construction:

(1) Lower dynamic mass and therefore better transient response.

(2) Elimination of the magnet/voice coil/pole piece assembly which means that there is no possibility of a "rubbing voice coil" and no gap to become contaminated.

(3) The piezo electric tweeter offers a very high impedance which falls with increasing frequency (but is still over 20 ohms at 40kHz). This gives the effect of a built-in filter network and protects the unit from damage by bass frequencies.

It has always been difficult to quantify loudspeaker power handling and the problem is even greater with piezo electric units. Even under conditions of high sound output, the device accepts very little power and is hardly recognised as a load by the amplifier.

Piezo electric tweeters present a reactive load and are rated on voltage rather than wattage.

Whilst the unit is unlikely to sustain damage under all normal conditions, a high level (say 35 volts r.m.s.) of a very high audio frequency will cause the driver to overheat and this will deactivate the ceramic elements.

If used with an amplifier with very extended treble response (100 kHz plus, as is the vogue with some manufacturers) h.f. instability could destroy the piezo unit. However, a *RC* filter has been incorporated into the crossover network which gives complete protection against this problem.

REFLEX DESIGN

As mentioned earlier, the EE70 is a "reflex" or "ported" design. For the uninitiated, a brief explanation of the reflex principle:

If an enclosure is fitted with a port open to the atmosphere, there is a particular frequency at which the air in the port will resonate with the stiffness of the air in the enclosure. This effect can be used to utilise some of the sound energy radiated from the rear of the speaker cone and maintain bass output with reduced cone excursion in the region of the speaker cone resonance.

If the port size is small, the speaker works effectively as a sealed box apart from the lowest bass frequencies where the port is tuned to "come on song" and augment the output of the bass unit.

The port can be tuned to extend the useful bass response of the speaker system—in other words, a lower bass frequency can be achieved than would normally be the case with an infinite baffle enclosure of the same volume and driven by the same power.

LISTENING TESTS

The EE70 loudspeaker presents a very "kind" load to the amplifier, with the impedance not falling below 8 ohms, apart from the normal peak at bass driver resonance where the impedance reaches 24 ohms.

Apart from the usual anechoic (echo-free) chamber tests, subjective listening tests played a large part in the development of the design.

Three well-respected commercial designs were used for reference purposes—the Kef 104aB, the Bowers and Wilkins DM2 II and the IMF ALS40 II. These were used for A/B tests on different types of music—piano, violin, full orchestra and rock. The EE70 was felt to compare favourably with the reference speakers and to be a very good investment at £150.

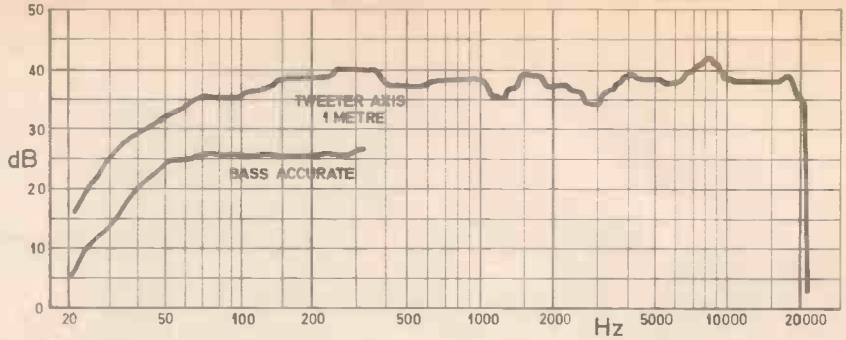


Fig. 1. Frequency response of EE70 Speaker System. Taken in small anechoic chamber. Actual h.f. response extends well beyond the 20kHz limit of the measuring equipment used.

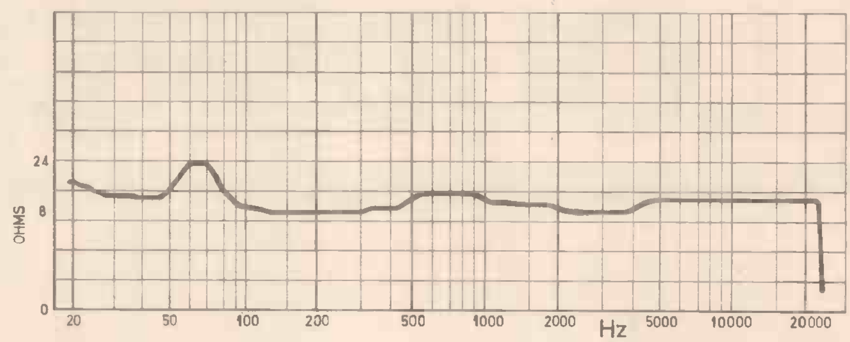


Fig. 2. Impedance/Frequency curve of EE70 Speaker System.

PLACEMENT OF UNITS

It will be seen that the treble and midrange units are offset in the cabinet. This confers some acoustic advantages in the bass enclosure; furthermore if the cabinets are made as a mirror image pair, this also makes it possible to have two choices for the "width" of the stereo image.

If the domestic environment dictates that the enclosures are placed too close together for optimum results, the stereo angle can be widened by offsetting the treble units to the outside, and conversely, if the speakers are too far apart the image can be narrowed by putting the treble units towards the inside.

CROSSOVER NETWORK

The crossover network circuit is given in Fig. 3. 12dB/octave networks are used in the high-pass, band-pass and low-pass sections at frequencies of 500Hz and 3000Hz approximately. Compensation networks (R4, C5 and R5, C7) optimise the system response. A treble unit protection filter (C2, R3) is incorporated.

A full size p.c.b. pattern is given in Fig. 4 and the layout of components is illustrated in Fig. 5. This arrangement is critical and should not be departed from.

CONSTRUCTION starts here

Full details of the enclosure construction appear in Fig. 1.

Flooring grade 18mm chipboard is used for the major part of the cabinet construction. The baffle board is made from good quality 18mm plywood. If rebating the drive units presents a problem, the baffle board can be fabricated from 12mm and 6mm ply glued and

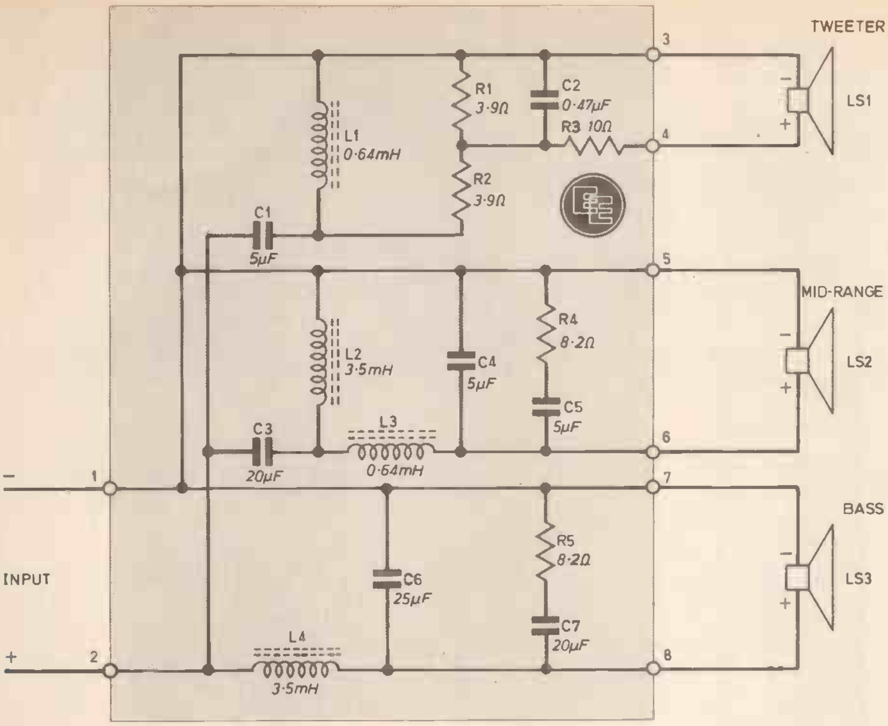


Fig. 3. Circuit of the EE70 crossover network.

screwed together. The specified speaker apertures are cut in the 12mm baffle and the 6mm ply is cut to the outside sizes of the bass and midrange units to provide a 6mm rebate when the boards are fixed together. Note that the piezo tweeter is not rebated—the same size aperture must be cut in both boards.

The midrange enclosure is a box of 12mm plywood measuring 180 × 210 × 178mm externally. It is filled with 80 grams of long fibre wool.

Sufficient glue should be used to ensure an airtight enclosure.

The cabinet is lined with laminated bituminous felt panels which stiffen the cabinet walls thus minimising the excitation of resonances at bass frequencies. These felt panels are fixed to the cabinet with Aquaseal No. 5, which is obtainable from builders' merchants. The pads should be held in place with, say, panel pins to maintain a good contact with the cabinet whilst the Aquaseal dries.

Do not fit the bass and midrange drive units into the cabinet until the glue is dry and the cabinet clear of fumes. The fumes from some adhesives can attack the Bextrene cone material with somewhat dire results.

FRONT TRIM OPTIONS

In the prototype enclosures, acoustically transparent foam was used for the front trim. This has a pleasing appearance and a high level of acoustic transparency and is easily fixed with the single-sided Velcro made specifically for this purpose.

An alternative frontal treatment is also illustrated. This uses a panel of veneered 12mm plywood as a surround for the treble unit.

Should conventional grille fabric be preferred, it will be necessary to make a grille frame and to use ordinary Velcro (hook and loop) for fixing this.

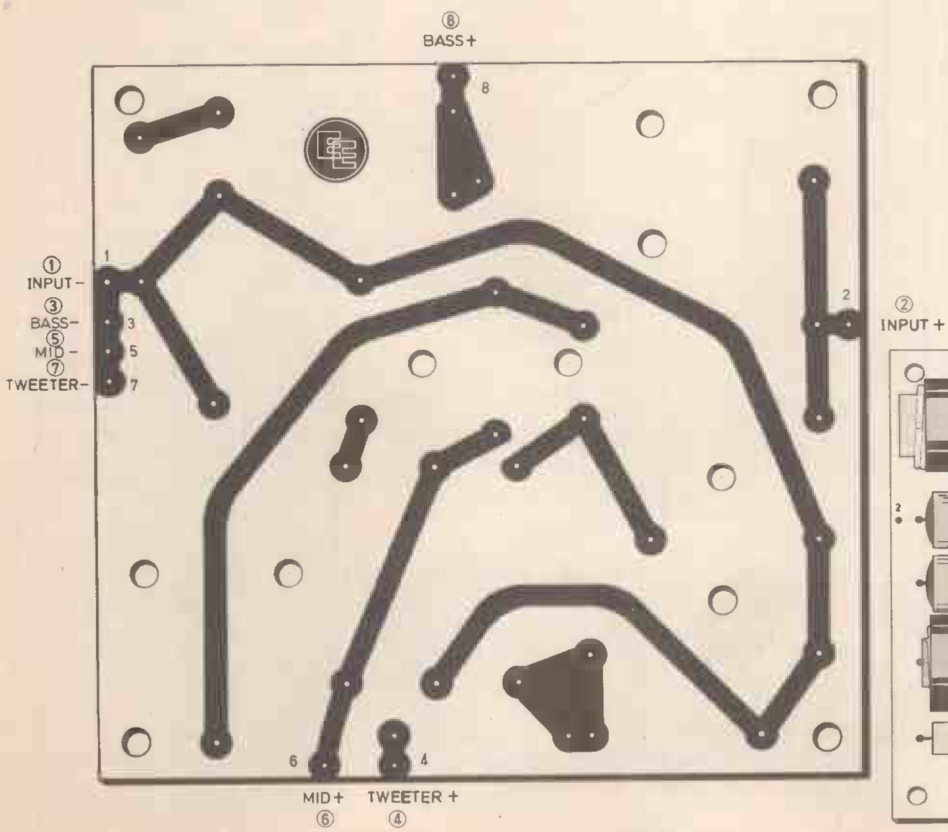


Fig. 4 (left) P.C.B. pattern for crossover network.

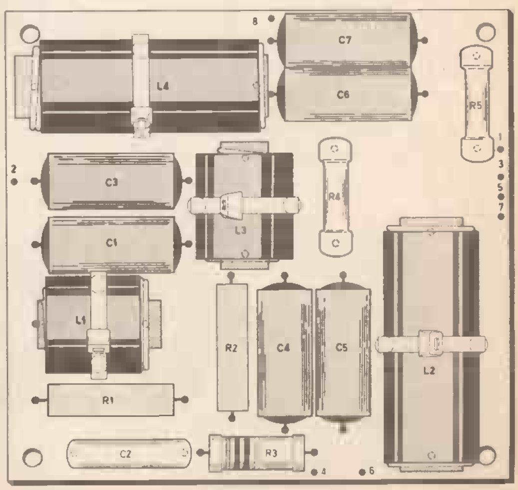
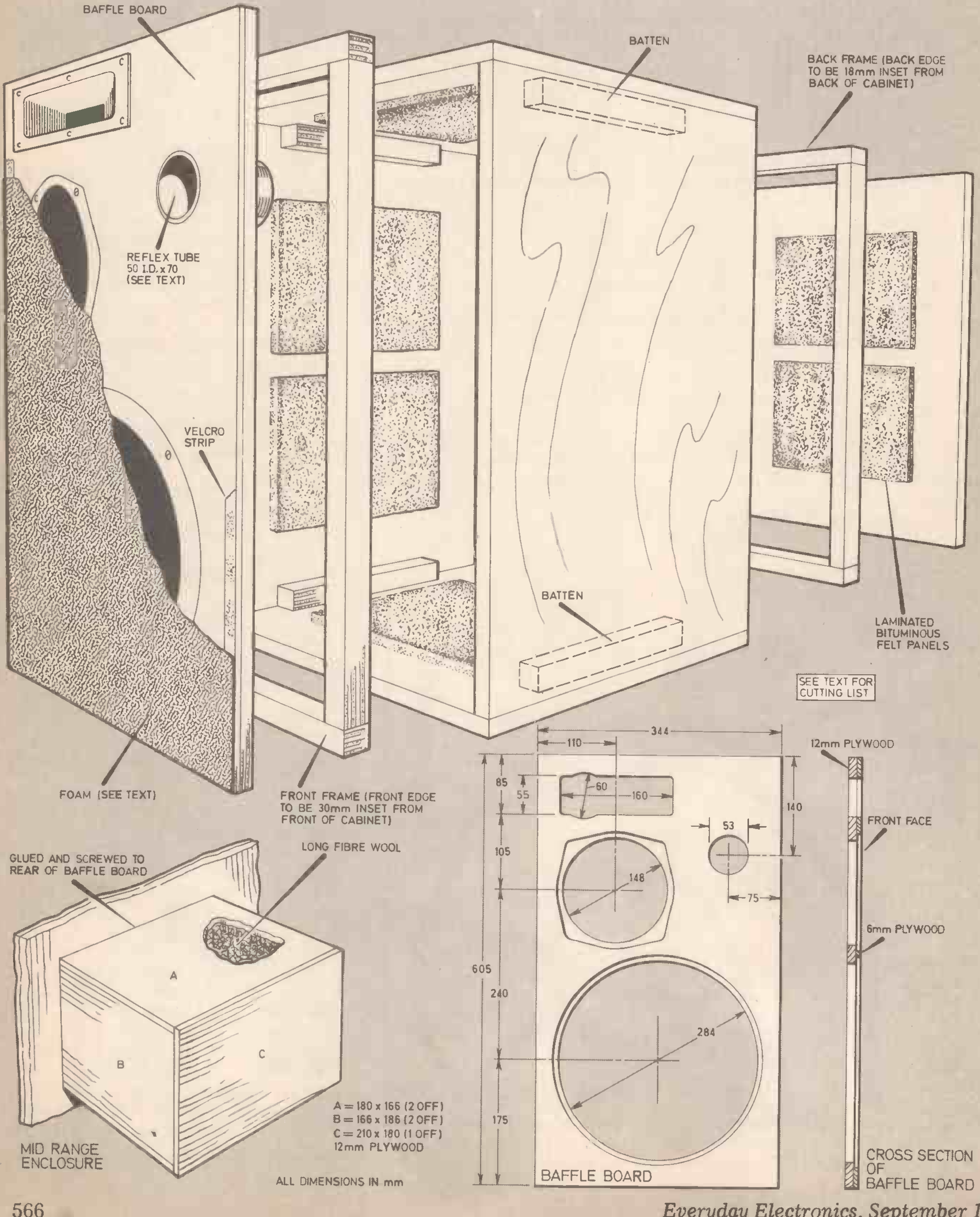


Fig. 5. Component layout for crossover network.

Fig. 6. Constructional details of the EE70 Reflex Enclosure.

ee70 reflex LOUDSPEAKER



BAFFLE BOARD ASSEMBLY

The reflex tube has an internal diameter of 50mm and a length of 70mm. This can be fabricated from cardboard, or plastic tubing as used for plumbing purposes can be used. When fixed in the baffle board the tube should be flush with the front surface.

As all three drive units are fitted from the front of the baffle board, the cabinet back panel can be permanently glued and screwed in place. The crossover network can be screwed inside the bottom of the cabinet, preferably on to a piece of foam rubber to prevent rattles.

The cabinet is lined with 2 inch Acoustilux bonded acetate fibre (BAF) wadding (1 sq yd per enclosure). This must be done before fitting the baffle board to the cabinet. No fixing is required for the Acoustilux, it is sufficiently rigid to stay in place without any support.

Gaskets are supplied with the D100/310 and D50/153 drive units, but it is necessary to make a rubber or paper gasket for the Motorola piezo tweeter.

COMPONENTS and MATERIALS

all quantities specified for one loudspeaker enclosure

Resistors
R1, 2 3·9Ω 5W (2 off)
R3 10Ω 2W
R4, 5 8·2Ω 5W (2 off)

Capacitors
C1,4,5 5μF reversible electrolytic, 50V ("Elcap") (3 off)
C2 0·47μF polyester
C3, 7 20μF reversible electrolytic, 50V ("Elcap") (2 off)
C6 25μF reversible electrolytic, 50V ("Elcap")

Inductors
L1, 3 0·64 mH 9mm ferrite core (2 off)
L2, 4 3·5 mH 12mm ferrite core (2 off)

Drive Units
LS1 6 × 2 inch horn piezo electric tweeter Motorola KSN 6025A
LS2 6½ inch midrange unit Dalesford D50/153
LS3 12 inch bass unit Dalesford D100/310

Miscellaneous
Stripboard or p.c.b. for c/o unit. Four tyraps. Eight 2BA T nuts and bolts. Six No.6×¾ in black japanned screws. Reflex tube 50mm internal diameter × 70mm long. Recessed connector panel or DIN loudspeaker socket. Eight laminated bituminous felt panels 13 × 230 × 270mm. Cable for internal wiring (0·75mm² for bass unit and from input socket to crossover). Acoustically transparent foam. Single-sided Velcro, 2·25 metres. Glue, screws, panel pins. Veneer for cabinet finish.

TIMBER CUTTING LIST

Cabinet
18mm Chipboard
605 × 355 (2 off)
380 × 355 (2 off)
605 × 344
25 × 25mm batten 5 metres

Baffle Board
6mm Plywood 605 × 344
12mm Plywood 605 × 344

Midrange enclosure
Plywood 210 × 180
180 × 166 (2 off)
166 × 186 (2 off)

(all dimensions in millimetres)

A kit for a pair of EE70 loudspeakers is available from Wilmslow Audio Ltd., Swan Works, Bank Square, Wilmslow, Cheshire.
The kit comprises:
2 Dalesford D100/310, 2 Dalesford D50/153, 2 Motorola KSN 6025A, 2 crossover networks, 2 yd. Acoustilux Wadding. 160 grammes long fibre wool. 16 T nuts and bolts. 12 black japanned screws. 2 DIN loudspeaker sockets. 2 reflex tubes. 2 badges.
Price: £150 including VAT
Carriage and insurance £5.

USING THE EE70 SPEAKERS

Careful siting of hi fi stereo speakers is an important factor in achieving optimum results. The domestic environment is usually far from perfect acoustically and the time spent in experimentation with different speaker positions will be well repaid.

If you are troubled with problem room resonances the quickest way of locating the best speaker position is to change places with the speakers! Listening to one speaker only, position this where you normally sit when listening to your hi fi equipment and position yourself where it is intended to site the speaker. Playing a record or tape which shows up the problem resonance (or easier still using a signal generator feeding the amplifier at low power) move around until you find the best position. Wherever your head is, that's the optimum position for the speaker! Repeat the process for the other channel.

Speaker leads should be of good conductor size — minimum 0·75 sq mm and preferably 2·5 sq mm/79 strand (though this is rather expensive if a long run is required).

The enclosures should be mounted on stands for best results. Suitable types are Tannoy TS4 or Target TAP2, though no doubt there are a number of others which would be suitable.

Finally, remember that the better a loudspeaker, the more faithfully it will reproduce the audio information fed to it and by the same rule, the more it will show up deficiencies in the rest of the hi fi system. ¤

MICROPROCESSOR BASICS

By R. W. Coles

WE HAVE now covered most of the ground necessary to gain a basic understanding of what microprocessor chips and systems are all about.

At this point many readers will no doubt be happy to leave the subject and return to their interest in the more traditional aspects of electronics. Microprocessors are certainly not everyone's idea of fun. They are, after all, so expensive, complex, fragile, and just plain difficult, that the sensible may be deterred from venturing any further down that slippery slope to micro-addiction!

But let's face it, there *is* something fascinating and compelling about the challenge of microprocessors, and there are some readers, I'm sure, who can't wait to get started.

CHOOSING A SYSTEM

It is vital to choose a first system carefully, since it could turn out to be the cause of much frustration (if you choose badly) or the cause of an awakening to the joys of home computing (if you choose well)!

The problem is, for most of us, the one of system cost. It's no use me saying that you will get on better with a £500 system than with a £50 system—I expect you have guessed that already! There is no easy answer to this problem of course, microprocessing *is* expensive, but it can be helpful to define at the outset just what you hope to gain from any system you buy. In this way you can soon discover whether you are being too ambitious for your available funds!

Having rejected the idea of buying a £50 system which can be programmed to beat Boris Spasky at chess, you can then work out just what *is* possible within your own budget!

TABLE

You may find Table 7.1 of some assistance to you when you come to choose a system. The table is an attempt to summarise what you can hope to achieve for a given outlay, using a "star rating" system. Down the left hand side are some of the possible uses to which a microprocessor system could be put, and no doubt you will be interested in more than one of these.

The table is split up into four columns each of which corresponds to a particular price range and system class. It is not intended to be an exhaustive or scientific analysis of available microprocessor systems. The table has been compiled subjectively and is intended only as a guide for those readers who are finding a choice difficult in the face of the bewildering variety of advertisements for microprocessor systems which can currently be seen in catalogues and hobby magazines.

The star rating system is self-explanatory, but I should point out that an attempt has been made to take account of cost-effectiveness. This means that alongside "Use for small dedicated control systems" the systems in the £100 plus class get the most stars, even though the £300 plus systems could do the job just as well from a functional point of view.

HEX OR ALPHA NUMERIC

The four columns can be split into two distinct groups, those systems which are machine code orientated, usually with hexadecimal keyboards and displays, and those which are capable of supporting a high level language and therefore having alphanumeric keyboards and displays.

The systems in the other two columns are often described as "Evaluation Cards" or "Microcomputer Cards" but I would prefer to call them Machine Code Systems.

The systems in the other two columns are usually referred to as "Home Computers" or "Personal Computers", and these are both fairly apt titles.

TABLE 7.1

	MACHINE CODE SYSTEMS		HOME COMPUTERS	
	① SINGLE BOARD HEX. KEYBOARD LOW COST (£40+)	② EXPANDABLE HEX. KEYBOARD (£100+)	③ PACKAGED SYSTEM SINGLE BOARD (£300+)	④ BUS ORIENTATED EXPANDABLE (£1,000+)
LEARN MICROPROCESSOR HARDWARE.	□□□	□□□□	□□	□□□□
LEARN MICROPROCESSOR MACHINE CODE PROGRAMMING.	□□	□□	□□□	□□□□
LEARN HIGH LEVEL LANGUAGE PROGRAMMING.		□	□□□	□□□□
USE FOR GAMES	□□	□□□	□□□□	□□□□
USE FOR SMALL DEDICATED CONTROL SYSTEMS.	□□	□□□□	□	□
USE FOR DATA PROCESSING APPLICATIONS.	□	□□	□□□	□□□□
USE AS FOUNDATION OF EXPANDED SYSTEM.	□	□□	□□□	□□□□
TOTALS	11	18	19	25

MACHINE CODE SYSTEMS

As you can see from the table, Machine Code Systems are more hardware orientated than the Home Computers, and they are also very much cheaper. A typical system of this sort would use an 8 bit microprocessor and would be supplied with less than 1K byte (K=1,024) of RAM. The printed circuit card on which the system is assembled would normally support a seven segment l.e.d. display and a hexadecimal keyboard as well as all the electronic components, and the better systems would include a tape interface for storing data or programs on cassettes.

SOFTWARE

Software is provided in the form of a Monitor program stored in a ROM or PROM and this, in conjunction with the keyboard and display, allows the user to enter programs in hexadecimal (machine-code) format, to examine or modify them, and to run them when required.

Some input/output lines are usually provided for the addition of special peripheral circuitry, and system expansion can sometimes be achieved by extending the system buses, but the possibilities for adding extra facilities are often quite limited.

The low cost systems of this type (column 1) are the cheapest way to get into microprocessors but most people find the facilities provided by these systems rather limiting after a while, and expansion is usually difficult. A typical example in this class would be the Science of Cambridge Mk 14.

EXPANSION

By spending a little more (column 2) you can get a system which is still basically of the same type, but in this case the designers will have taken a little more care to provide easier expansion so that a more capable system can be built up in stages.

A good example in this class is the Commodore KIM-1 which has the companion boards KIM-3 (8K RAM) and Kim-4 (Motherboard to join KIM-1 to several KIM-3 boards) available for system expansion. Another example is the now famous NASCOM-1, which can be expanded to almost Home Computer standards.

The NASCOM I computer system for the home user.

PROGRAMMING

Programming in machine code can be a tedious (if fascinating!) business, and it is necessary to develop a very clear understanding of the internal operation of the microprocessor chip in order to program successfully. Looked at from a different point of view, this can mean that struggling with the intricacies of machine code programming will teach you a great deal about microprocessors!

When you have mastered the art, you should be able to write 256 bytes of successful program in about 10-20 hours, so you can see why the RAM size of these systems is usually not more than 1K.

If you become interested in simple controller tasks—burglar alarms, model train controllers, car instrumentation and so on—then 256 bytes of program can do quite a lot for you, and you may be happy to continue with a simple system.

If, on the other hand, you relish the thought of writing programs to solve simultaneous equations, or you want to simulate spacecraft landing on Mars, or even produce graphics on a VDU screen, then the systems in columns 1 and 2 can provide little more than a general introduction to the subject of microprocessors for you. Eventually you will need to move on to columns 3 and 4 where the Home Computers are to be found!

HOME COMPUTERS

Home Computers are orientated towards software, and it is the availability of "System software", as it is called, which sets these systems apart from the Machine Code Systems in both performance and price. The most fundamental Home Computer advantage is the provision of a High Level Language such as BASIC.

With the machine code or Hex Monitor programs of the cheaper systems you have to talk to the microprocessor chip in its own language. The commands you can include in your programs are those listed in the micro' data sheet, and numbers must be in binary or the equivalent hexadecimal form. When using "Transfer of Control" or "Jump" instructions you have to work out the precise memory location to which you wish to jump, and then enter it in hex format—a tedious business!

BASIC

Using a High Level Language like BASIC things get much easier. Now you can type in program statements which are in English, numbers can be in decimal, and transfer of control is taken care of by using number references which are not direct memory addresses but the decimal numbers you have used to prefix each line of program. Here is an example:

```
10 PRINT "THIS PROGRAM
   ADDS TWO NUMBERS TO
   FORM A SUM"
20 PRINT "ENTER TWO NUM-
   BERS A AND B"
30 INPUT A, B
40 PRINT "A+B=" A+B
50 GO TO 20
60 END
```

The Acorn microcomputer may serve as a low cost development system, a self-contained computer for the home enthusiast and can be expanded for full scale computer operation.

The Compucolor personal computer features a 13-inch 8-colour VDU, a 72-key keyboard, a built-in floppy disk drive and 8K RAM. The price is £1,390.

This is a very simple program of course, and BASIC can do much better things than just adding two numbers together. This simple routine does, however, indicate the ease with which programs can be written in BASIC, and also shows how understandable the results can be, even for non-programmers!

At the heart of a Home Computer there lies exactly the same sort of microprocessor chip as can be found in a Machine Code System, but in this case someone has gone to a lot of trouble to write large, machine-code programs which can convert decimal numbers to binary, can interpret BASIC statements such as INPUT A, B into machine operations, and can even perform mathematical and trigonometric operations which could take you or I months to write in machine code.

INTERPRETERS

These programs are called Interpreters in the case of the BASIC language, and they can occupy between 8K and 48K bytes of memory, depending on their capability. A typical Interpreter for a Home Computer BASIC would occupy about 8 kilobytes, but there is a smaller Interpreter for a simplified language called TINY-BASIC which can fit into only 2K bytes.

These Interpreters can be stored in ROM or RAM memory, although the latter possibility requires that you reload the interpreter, from magnetic tape for example, each time you turn on the power. Inputs and outputs are now completely alphanumeric, and so the hex keyboard and seven segment l.e.d. displays of the cheaper systems have to go.

It is of course the cost of the large memory, alphanumeric keyboard, and VDU or printer output device which elevates the price of the Home Computer into a class of its own, but as shown in Table 7.1, there are dividing lines which can be drawn within the Home Computer bracket.

PACKAGED SYSTEMS

The least expensive of the Home Computers come as complete packaged systems, and perhaps you have seen examples such as the Commodore PET or the Tandy TRS 80 which fall into this class. Features of these systems are the emphasis on low cost (about £600 and £500 respectively) the TV type display, the tape cassette drive for program loading and storage, and the provision of a BASIC Interpreter in ROM.

These systems have become very popular in both the UK and the USA, although their relatively higher cost in the UK has made them more attractive for small business and scientific applications than for the "fun-and-games" they are often used for in the USA.

These systems are not easily expanded, although their sheer popularity has caused a number of hardware expansion features to be marketed along with a large quantity of software available on tape. I would have no hesitation at all in recommending these systems for hobby use, but would warn that they are hardly the best foundation on which to build a future, much expanded, system.

BUS SYSTEMS

Better systems to buy as foundations for expansion are available as "Bus Orientated Systems." In this case you buy a box containing a microprocessor board, a RAM board and an interface board, all plugged into a "Backplane" or "Motherboard" which has several unoccupied slots. To expand your memory or interfaces in the future, you have to do little more than plug in extra printed circuit boards containing the appropriate extra components.

Most professional computers are based on a Bus structure, but unfortunately it is a more expensive way to buy a small system because of the expensive connectors and the need to partition the boards into logical sub-systems.

S100 BUS

There is a special Home Computer bus standard called S100 by its designers who introduced it on the very first microprocessor based Home Computer worth the name, the MITS Altair 8800 launched in 1975. Since that time the S100 has become very popular, despite some criticism, and now there are literally hundreds of S100 board types which can be put together to form the system of your dreams!

Most S100 systems use a separate VDU and keyboard, or teletypewriter for communication, but the range of other peripherals which can be added is huge and

The Tandy TRS—80 model 11 microcomputer. One of the most popular home computers.

includes tape cassettes, floppy discs, line printers, speech synthesisers and modems. Examples of S100 systems are the Cromemco Z-2 which is based on the Z80 microprocessor, and of course the 8080 based 8800 which is still popular.

Perhaps the most useful feature of the S100 bus is that you don't *have* to buy a *system* as such. You can build up your own system from scratch by buying a motherboard and plugging in compatible cards to meet your own requirements. You can even build your own boards if you wish because there are lots of S100 board kits, and also prototyping cards for those who wish to design their own memory or interface circuits.

FUTURE

The picture presented in Table 7.1 is that of a neatly ordered market which splits logically into four categories. Unfortunately it isn't quite that easy as you will discover if you carry out your own market survey! Some systems currently advertised could fit into two of my categories equally well, others don't seem to fit in at all.

All I can say is that introducing extra categories would make things a little too complicated for those who are new to the microprocessor "game!"

In the future we can expect to see prices falling dramatically and systems in the Home Computer columns becoming cost competitive with the Machine Code Systems. I think that it would be very unwise to suppose that there isn't a microprocessor lurking *somewhere* in your future, so why not come to grips with this steam-roller technology right now, before it comes to grips with you! ⌑

Retailer's dues

I have no doubt that you are all too aware of "Mother's Day", "Father's Day" and other American imports designed to promote the sale of cards and gifts among the more naive members of the community. I intend to add yet another; "Component Retailer's Day". This will be celebrated on mid-summer's day. I choose this day, because June is always the worst month businesswise (I can prove it by my records) and therefore the middle of the month is where the poor fellow reaches his nadir.

As he sees his cash flow dying down to a trickle and runs out of finger nails, how nice it would be if his customers rallied round and gave him a few nice large orders (beautiful lady customers could give him a big kiss in lieu).

Go slow

To add to our misery this year, the Post Office decided to go slow, with the result there were over 30 million letters in the pipe-line, many were en-route to retailers like myself containing orders and money.

In a slightly more serious vein, I have said it before and I say it again, your Component Retailer is a dedicated chap, because he can not be in it for the money, he would make far more selling fish and chips and this should be a comforting thought to all our readers. I must confess however, that a number of component suppliers, including some big names, have fallen by the wayside. Fortunately, on the credit side, there still seem to be many new ones ready to fill the gap.

Static last word

Now a final word on the static conundrum. Mr. David Mayne has kindly sent me an article from an American magazine *The Amateur Scientist* dated March 1959. The author is talking about thunderstorms and makes the following observations, "A portion of the energy liberated by lightning takes the form of electromagnetic waves called sferics. These account for the familiar static heard on radio receivers".

He includes in his article a circuit for measuring these, the idea being that the results could be used for short term weather forecasts. The circuit uses valves but no doubt it could be redesigned to use transistors. I'm all in favour, but I would give this word of warning. It could be regarded as a fun thing only, because all one can say about short term forecasts, is that they are slightly more accurate than long term forecasts and just in case some of you are saying "What does old Paul Young know about meteorology?!!", I will tell you.

I held a Commercial Pilot's Licence for ten years and one of the most difficult of the exams was Meteorology. Captain Young failed it twice, before he passed. The examinee who does that always knows ten times more about the subject than the one who passed first time. Finally another factor that would upset the forecasting is that thunderstorms invariably go round in circles! Well that just about winds up the case for static.

Most electronics enthusiasts at some stage in their life are amazed by disco lighting equipment. There is almost an air of secrecy surrounding the "black box", which creates this instant atmosphere.

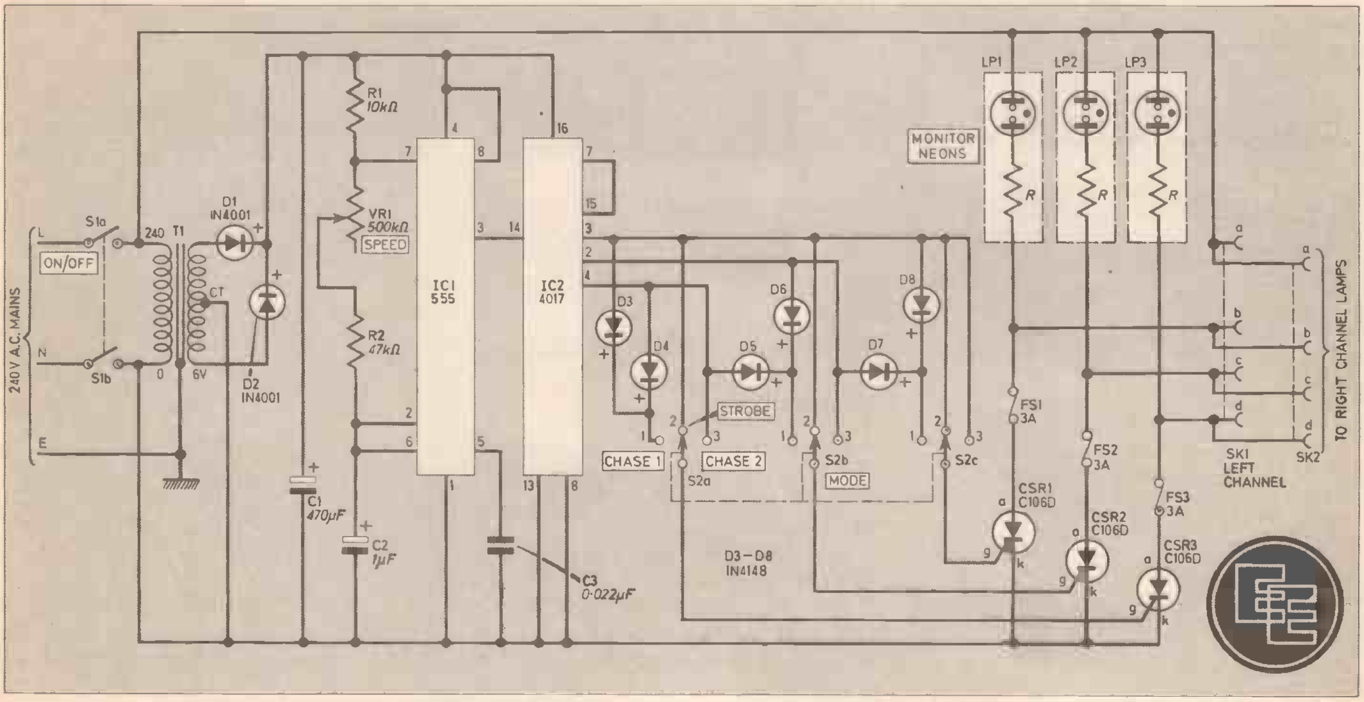
This article removes the secrecy giving amateurs the chance to produce a unit which is equal to or better than a commercial equivalent costing several times more. Even if you are not interested in discos the heart of this circuit is very versatile and may answer some of your needs.

The unit described will drive a mains voltage display to a maximum of 750 watts per channel, making it suitable for small discos or domestic parties. It offers three modes of flashing; two chases and a strobing function.

USE OF LOGIC

Over the years many designers have found uses or "mis-uses" for logic integrated circuits far fetched from their intended purposes. Most of these use gates and inverters, the main reason being that an i.c. can be cheaper than a single discrete transistor. The circuit to be described does not fall in this class, as the main i.c. performs a complex function enabling an almost impossible task, when using discrete components, to be carried out with the greatest of ease, while at the same time leaving open many options.

This i.c., a CMOS device, counts pulses using a decimal number system. But by connecting the reset pin to the output one above the maximum number required the counter can perform a "divide-by-*N*" function. In this circuit the reset pin is connected to the fourth output so that upon application of clock pulses the i.c. will count from 0, 1, 2 and then counts 3, but this returns the output to zero, giving rise to the overall pattern 0, 1, 2, 0, 1, 2 . . . etc., as the outputs go high sequentially.



CHASER LIGHT

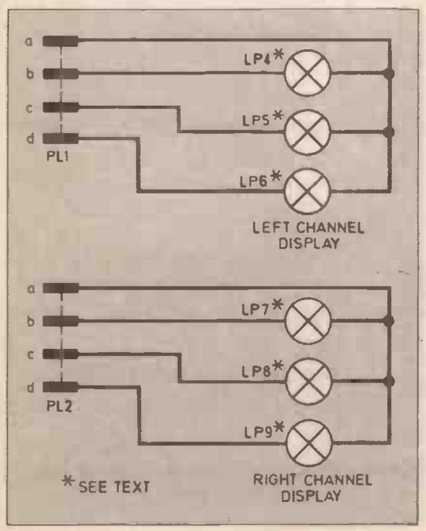
The logic circuitry is used to control thyristors which in turn control the lights. Although thyristors only possess the ability to switch on during positive half cycles this has several advantages one being the reduced stress on the bulbs, therefore increasing the bulb life.

CIRCUIT DESCRIPTION

The complete circuit diagram of the Chaser Light is shown in Fig. 1. The circuit can be separated into five basic blocks, low voltage supply, clock oscillator, counter, selector switch, power switches.

Mains voltage enters the unit and is stepped down to 6V-0-6V by transformer T1. This alternating voltage is rectified by D1 and D2 and smoothed by C1. Unlike TTL i.c.s, CMOS devices do not require a stabilised supply hence this simple arrangement is adequate.

Fig. 1 (left and below). The complete circuit diagram for the Chaser Light.



CLOCK OSCILLATOR

The clock oscillator is based on IC1, a 555 timer i.c. In this application the 555 is wired in its astable mode. When the voltage on C2 is less than two thirds the positive supply voltage pin 3 is at 0V. The capacitor charges through R1, R2 and VR1.

When the voltage on the positive plate of C2 reaches two thirds of the supply, the internal circuitry resets and causes pin 3 to go high. Simultaneously the i.c. switches pin 7 to 0V, hence C2 discharges through R2 and VR1.

When the voltage drops to one third of the supply voltage the internal circuits reset and once again C2 is able to charge via R1, R2 and VR1. The cycles thus repeat giving a squarewave output at pin 3.

The frequency of this oscillation is given by:

$$f = \frac{1 \cdot 44}{[R1 + 2\,(R2 + VR1)] \times C2}\ \text{Hz}$$

where the capacitance is in farads, and the resistance in ohms.

The maximum speed is obtained with VR2 at minimum and is equal to 14Hz. Minimum speed (VR2 maximum) is 1·3Hz.

In practice these values may be different due to the tolerance of the components.

The counter chip IC2 has ten outputs, only one of which is high at any one time. The high output pin is dependent on the number of pulses applied to the clock input. Only three of these outputs are used in this circuit, these are taken from pins 2, 3 and 4 of the 4017. A fourth output pin 7, is used to reset the counter.

The truth table shown below shows what is happening.

Table 1. Truth table for CD4017 with reset connected to fourth output

Clock	Q_0	Q_1	Q_2
0	1	0	0
1	0	1	0
0	0	1	0
1	0	0	1
0	0	0	1
1	1	0	0
0	1	0	0
1	0	1	0
	etc		

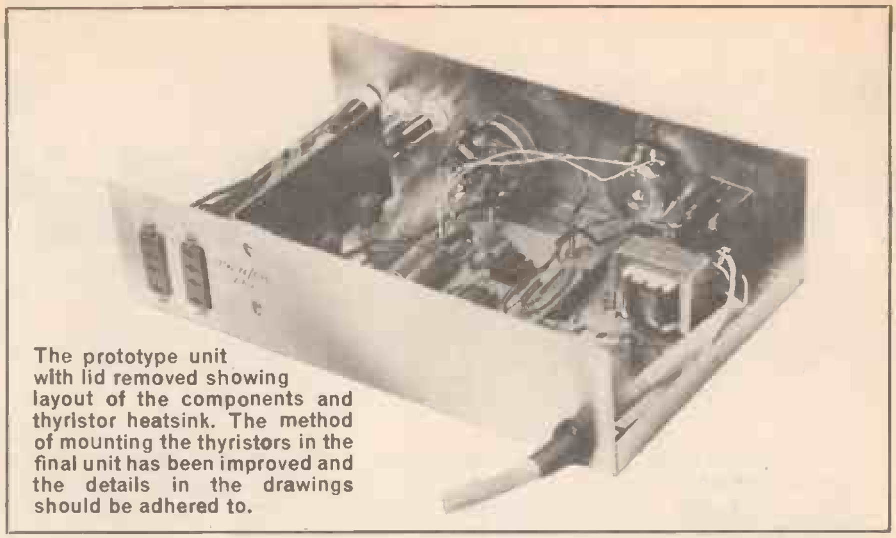
THREE MODES

The MODE S2 selects to which of the outputs the thyristor gates are connected. In position 1 the thyristors are connected to two outputs, hence only when the third output goes high are they able to switch off, the lights therefore switch off sequentially, two lights being on at any one time.

In position 2 all the lights are controlled by one output of the counter, hence the lights flash simultaneously with a mark/space ratio of 1:2.

In the third position one thyristor is connected to each output, hence the lights come on sequentially, but different from position 1.

The thyristors behave like an open circuit until a voltage is applied to the gate terminal when the thyristor then snaps into conduction thereby placing mains voltage across the associated bulb causing it to light. The light remains on until the voltage between the thyristor anode and cathode is reduced to zero i.e. at the end of every mains half cycle. Thus a train of pulses into the counter causes the lamps to flash on and off, the overall effect controlled by the position of S2. Panel neons serve to monitor the outputs.



The prototype unit with lid removed showing layout of the components and thyristor heatsink. The method of mounting the thyristors in the final unit has been improved and the details in the drawings should be adhered to.

CONSTRUCTION starts here

CIRCUIT BOARD

Some of the small components are mounted on a piece of 0·1 inch matrix stripboard, size 19 holes by 34 strips as shown in Fig. 2, which also shows the breaks to be made on the underside. Begin by cutting the board to size. Make the necessary breaks in the copper strips and drill the mounting holes. At this stage it is advisable to clean the board with either some scouring cream or steel wool. This ensures that any grease and oxidation is removed and helps the solder flow.

Start construction by inserting the i.c. sockets, without the integrated circuits, and solder them in place. Next using these sockets as a guide insert the wire links. It is advisable to use coloured single cored wire, as this makes checking easier. At this stage the flying leads should be soldered in position; 20cm of wire should be attached to each position. These can be trimmed to size during later stages of construction.

The leads from the transformer are connected followed by the remaining components taking care to get the electrolytic capacitors the right way round and not to overheat the diodes. Use of a heatshunt is recommended.

The prototype was housed in a Norman WB3 case, which is available from many retailers and is strongly recommended. With reference to Fig. 3, drill the mounting holes for the chassis mounting parts. A piece of 16 s.w.g. aluminium 100mm x 35mm is required for use as a heatsink for the transistor as shown in Fig. 3. The five mounting holes are drilled then the sheet is bent to shape.

THYRISTOR MOUNTING

It is essential that a mica washer and insulating bush is used when mounting each thyristor as the "tab" is internally connected to the anode of the device. Note that the tab of each thyristor needs to be bent at right angles to the body.

It is also recommended that a heatsink compound is used when mounting to produce good thermal contact. This compound could also be used at the bracket/chassis interface.

On the prototype two polarised four-pin sockets were mounted to take the output to the bulbs. The type used on the prototype are available from Maplin. Other types may be used such as octal or the commonly used Bulgin P551/P552 combination with minor adjustments to the layout of these sockets on the back panel.

COMPONENTS

See Shop Talk page 590

Resistors
- R1 10kΩ
- R2 47kΩ
- Both ¼W carbon ±5%

Potentiometer
- VR1 500 kilohm carbon lin.

Capacitors
- C1 470μF 10V elect.
- C2 1μF 6V elect.
- C3 0·022μF polyester type C280

Semiconductors
- D1, D2 1N4001 or similar silicon rectifier diode (2 off)
- D3 to D8 IN4148 or similar silicon diode (6 off)
- IC1 NE555 timer i.c.
- IC2 CD4017 CMOS decade counter/divider
- CSR1,2,3 C106D or similar 500V 6A thyristor (3 off)

Miscellaneous
- T1 Miniature mains primary/6V–0–6V 100mA secondary (e.g. Eagle MT6)
- S1 d.p.s.t. mains 6A toggle
- S2 3-pole 3-way rotary switch
- FS1,2,3 3A 20mm plus chassis mounting fuseholders (3 off)
- LP1,2,3 mains panel mounting neons, 1 red, 1 green and 1 clear (3 off)
- SK1,2 4-pole panel mounting sockets (2 off)
- PL1,2 4-pole plugs to suit SK1,2 (2 off)

Stripboard: 0·1 inch matrix, 34 strips × 19 holes; mains cable grommet; 16 s.w.g. 100 × 35mm aluminium (thyristor heatsink); 6A 3-core mains cable; case WB3 or similar, dimensions 200 × 130 × 50mm; mica washers and bushes for thyristors (3 sets); heatsink compound; 6BA fixings; control knobs (2 off); 6A insulated wire (power wiring).

CHASER LIGHT

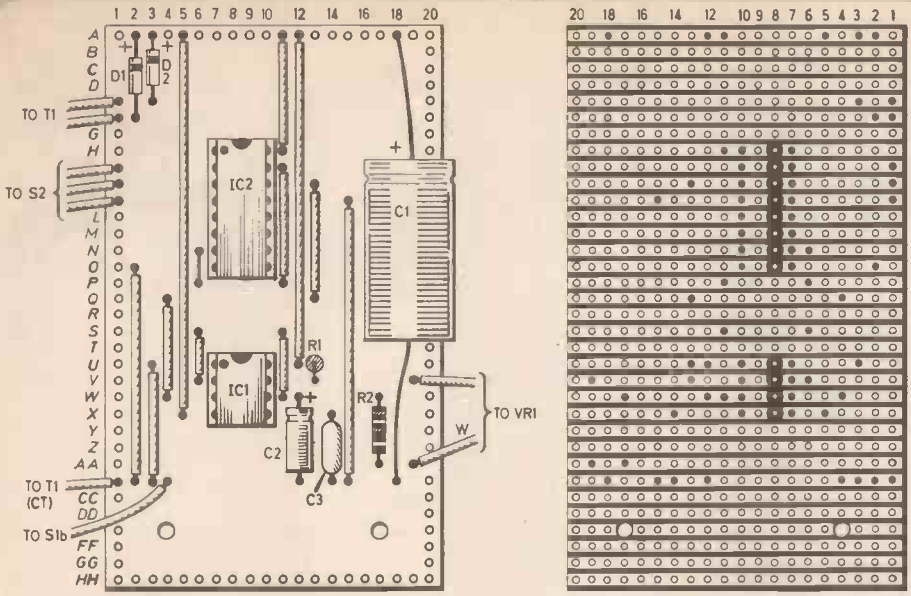
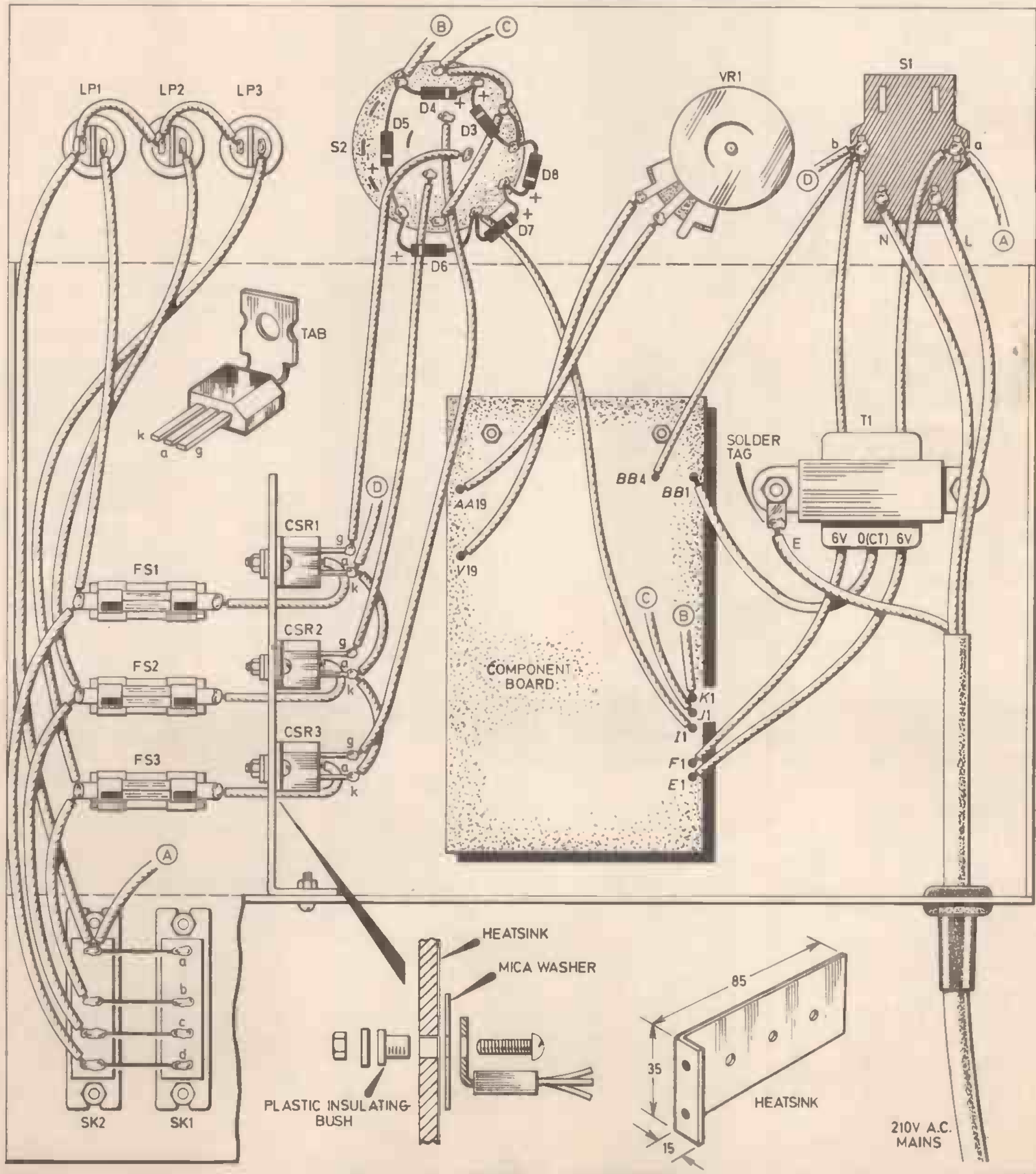


Fig. 2 (left). The components mounted on the topside of the stripboard and the breaks along the copper strips to be made on the underside.

Fig. 3 (below). The case opened out to show component and board positions and complete wiring details. Also shows the thyristor heatsink and method of mounting the devices. The use of insulation sets on the thyristor is essential as the mounting tab is internally connected to the anode.



The authors completed light box with the transit cover in position.

Side panel removed showing light box framework.

Back panel removed showing lampholder wiring.

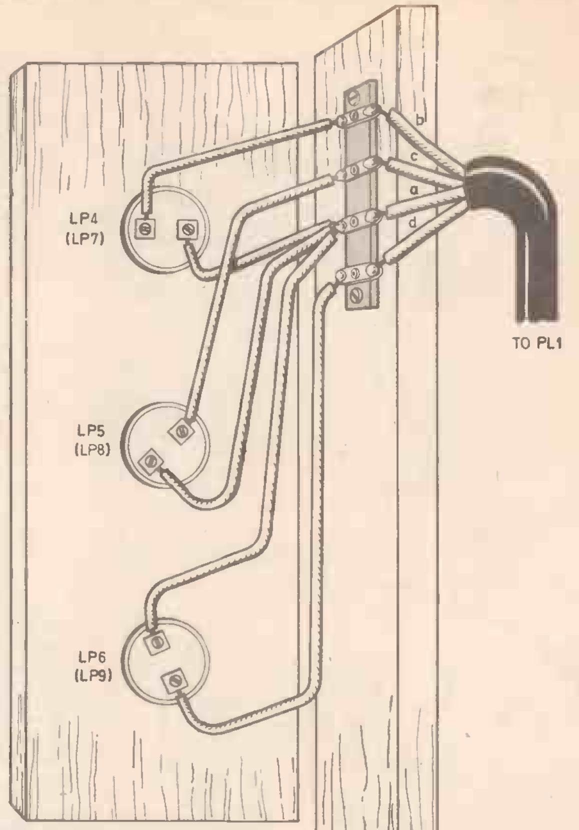


Fig. 4. The wiring between mains lamp holders and tagstrip for takeoff to suitable plug.

Should these be hard to find or their expense not be justified they can be replaced by a piece of insulated screw terminal strip, although the plugs and sockets are preferred for mobile use.

The rotary wafer switch is best wired up prior to being positioned inside the case. Once the sub-assemblies are completed they can be bolted to the case using countersunk 6BA nuts and bolts and shakeproof washers. The flying leads may then be soldered to their appropriate points. This should be followed by the heavier mains wiring. See Fig. 3 for complete wiring details.

Once completed and thoroughly checked, not forgetting to make sure that the underside of the stripboard is not touching the case, the i.c.s may then be put into their sockets, taking special care with IC2 which being of CMOS construction is sensitive to static electricity.

The circuit is now ready for testing; place S2 to its central position, and VR1 set midway, plug in and switch on, if all is well the panel neons should all flash together. Turning VR1 should change the speed, clockwise to increase and anticlockwise to decrease. If that happens, turn S2 to the other positions to check the two modes of Chase.

LAMP HOUSING

Construction of this project does not finish with the control unit, "light boxes" need to be made. The choice of lamp housings is a matter of personal preference, to some extent being determined by one's woodworking skills and also by the amount of money available. The display may be simply three batten holders screwed to a length of wood.

Lamp and wiring details are given in Fig. 4 and the "light boxes" used by the author are shown in the photographs. These were designed so that the bulbs, 100 watt coloured spots, could be left in place during transit protected by a clip-on front panel. The exterior was covered with black vinyl giving a very durable and professional finish.

The lamp housings are connected to the control unit by 4-core mains wire, which was obtained from Tandy, who stock it for use with their aerial rotators. ♮

COMPONENTS approximate cost £14 excluding lightbox

For your ENTERTAINMENT

By ADRIAN HOPE

Are you Bugged?

As a matter of policy most electronics magazines decline to publish constructional features on bugging or surveillance devices. What's more the use of bugging systems is usually illegal in Europe either because it involves unauthorised radio transmission or unauthorised tampering with a telephone.

This doesn't stop the sale of bugging devices and anyone with the inclination and the cash can usually find what they want. At a large European airport recently I noticed one of the most unsavoury of all bugging devices on open sale in the duty free shop for around £500.

For obvious reasons I am not going to identify in print (*or by letter in reply to any reader's request*) either the airport or the firm making the gadget. But a published description of what the gadget does should aid awareness of the risks we all now run and perhaps even help someone somewhere discover that they are already being bugged.

The £500 kit comes in two parts, both i.c. miniaturized modules, a monitor unit and a matching remote activator. The monitor unit is hidden inside a conventional telephone and is self powered by the voltage which is constantly on any telephone line. The monitor module contains a very sensitive microphone and amplifier which picks up sound from the room and outputs down the 'phone lines.

Normally the monitor unit is out of action but it can be activated remotely by a caller equipped with the matching module. The bugged telephone number is dialled and as the last digits register the activator module is held close to the mouthpiece of the calling telephone. The activator emits a high frequency tone which instructs the monitor module to prevent the called telephone bell from ringing and at the same time activates the monitor microphone.

Sound from the room is then relayed down the 'phone wires to the calling telephone. This can be across the road, the city or the world.

This particularly nasty gadget is not to be confused with the more conventional type of telephone bug which is a miniature transmitter hidden in a telephone and designed to pick up the sound of any calls made and transmit them by radio outside the room. The new device picks up sound from the bugged room while the telephone is still on its hook and it transmits no radio signals. It is thus much harder to detect than a conventional bug.

Double Exposure

A short while ago the two giant companies Xerox and IBM shook hands and dropped their accusations and cross accusations about infringements of no less than 27,000 patents. These all relate in one way or another, directly or remotely, to electrostatic copying or xerography.

As from now the two companies will work on the basis of a free mutual patent pool.

The strength of the Xerox patent folio has always been legendary and the original patents granted to Chester S. Carlson of New York have traditionally been regarded as the master patent foundation on which the whole Xerox copying monopoly was built. But history could well have been different if the existence of an obscure Belgian patent had been recognized.

Carlson's original patents date back to October 1937 and protect the basic concept of forming an image to be copied on a material which is an insulator in the dark and a conductor in the light. Carlson put an electrostatic charge on the material surface, exposed it to the image and then dusted the surface with black powder. The powder fell away from the areas discharged by the image light and stuck to the areas still charged, to produce an instant copy image.

But the meticulous records of the Belgian Patent Office show that at 10 o'clock on June 11, 1932 a certain Monsieur Marcel Demeulenaere of Brussels filed a patent No. 389155 on a process for "Photocopying without Development". This involved charging a selenium surface, forming an image on the charged surface and dusting it with dark powder to form an instant copy picture.

The original Carlson patents are long since dead and the legal relevance of the Belgian document that anticipated them by a full five years is purely academic. It would, however, be historically interesting to know whether Carlson and Xerox knew of the potential risk to their patent monopoly which was gathering dust on the Belgian Patent Office shelves.

Paradoxically the early Belgian patent was never printed for dissemination round the world. But copies are now obtainable direct from the Belgian Patent Office, thanks to the miracle of Xerox graphic copying.

Off the Record

Recently the Japanese musician Tomita, who specialises in synthesised music, was in the news because the Holst estate disapproved of his synthesised version of *The Planets* and had it banned here. But Tomita's *Planets* is available in Japan and when I was there recently with a group of British journalists they descended like vultures on the record shops to buy up every available copy, both for personal collections and gifts.

The latest Tomita album offers synthesised musical thoughts on the *Bermuda Triangle*, that area of tropical ocean where ships and aeroplanes have a nasty habit of disappearing without trace. Computer experts will be interested in Tomita's sleeve note for that album.

Encoded in the music, he writes, is a digital series of musical tones. If the memory of a micro-computer is interfaced with the output from a gramophone playing the Tomita record, then it will be programmed by these tones, in exactly the same way that a micro-computer is routinely programmed by interfacing it with a cassette tape on which are recorded a series of digital instructions.

The snag is that there are numerous standards for interfacing a cassette tape programme with a computer memory and Tomita has chosen Tarbell rather than the more commonly encountered CUTS or so-called "Kansas City" standard. I ploughed through a daunting pile of books in the Science Reference Library looking for details of the Tarbell transfer standard, but drew a blank.

Doubtless readers well versed in computer technology will be able to set us straight.

STEVENSON
Electronic Components

TTL

		7473	20p	74141	55p
		7474	22p	74145	55p
7400	10p	7475	25p	74148	90p
7401	10p	7476	20p	74150	55p
7402	10p	7485	55p	74151	40p
7404	12p	7486	20p	74154	65p
7406	22p	7489	135p	74157	40p
7408	12p	7490	25p	74164	55p
7410	10p	7492	30p	74165	55p
7413	22p	7493	25p	74170	100p
7414	39p	7494	45p	74174	55p
7420	12p	7495	35p	74177	50p
7427	20p	7496	45p	74190	50p
7430	12p	74121	25p	74191	50p
7432	18p	74122	35p	74192	50p
7442	38p	74123	38p	74193	50p
7447	45p	74125	35p	74196	50p
7448	50p	74126	35p	74197	50p
7454	12p	74132	45p	74199	90p

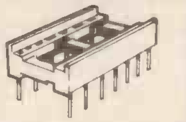
CMOS

		4020	50p	4050	25p
		4022	50p	4060	80p
		4023	13p	4066	30p
		4024	40p	4068	13p
4001	13p	4025	13p	4069	13p
4002	13p	4026	90p	4070	13p
4007	13p	4027	28p	4071	13p
4009	30p	4028	45p	4072	13p
4011	13p	4029	50p	4081	13p
4012	13p	4040	55p	4093	36p
4013	28p	4041	55p	4510	60p
4015	50p	4042	55p	4511	60p
4016	28p	4043	50p	4518	65p
4017	47p	4046	90p	4520	60p
4018	55p	4049	25p	4528	60p

FULL DETAILS IN CATALOGUE!

SKTS

Low profile by Texas



8pin	8p	18pin	14p	24pin	18p
14pin	10p	20pin	16p	28pin	22p
16pin	11p	22pin	17p	40pin	32p

Soldercon pins: 100:50p 1000:370p

PCBS

VEROBOARD Size in.	0.1in.	0.15in.	
25 x 1	14p	14p	Vero Cutter 80p.
2.5 x 3.75	45p	45p	
2.5 x 5	54p	54p	Pin insertion
3.75 x 5	64p	64p	tool 108p
3.75 x 17	205p	185p	
Single sided pins per 100	40p	40p	

Top quality fibre glass copper board. Single sided. Size 203 x 95mm. 60p each.
'Dalo' pens. 75p each.
Five mixed sheets of Alfac. 145p per pack.

OPTO

LED's	0.125in.	0.2in	each	100+
Red	TIL209	TIL220	9p	7.5p
Green	TIL211	TIL221	13p	12p
Yellow	TIL213	TIL223	13p	12p
Clips	3p	3p		

DISPLAYS			
DL704	0.3 in CC	130p	120p
DL707	0.3 in CA	130p	120p
FND500	0.5 in CC	100p	80p

RESISTORS

Carbon film resistors. High stability, low noise 5%.
E12 series. 4.7 ohms to 10M. Any mix:

	each	100+	1000+
0.25W	1p	0.9p	0.8p
0.5W	1.5p	1.2p	1p

Special development packs consisting of 10 of each value from 4.7 ohms to 1 Megohm (650 res) 0.5W £7.50. 0.25W £5.70.

METAL FILM RESISTORS
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	each	100+	1000+
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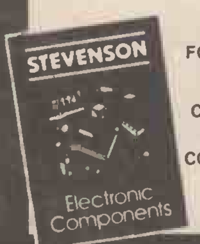

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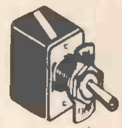

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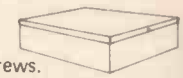

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CONSUMER ELECTRONICS

TECHNICIANS PREPARE FOR MAJOR ADVANCES ON THE HOME FRONT

NEWLY developed electronic equipment will present a challenge to those engaged professionally in installing and maintaining the latest consumer electronic products, for these are based on techniques not yet entirely familiar to the majority of service engineers and technicians.

To help start the urgently needed familiarisation process a four-day symposium on Consumer Electronics was held at the University of Essex in July. Organised by the Society of Electronic and Radio Technicians in association with the Incorporated Practitioners in Radio and Electronics, this meeting must have impressed the delegates with the advanced nature of the electronics that is beginning to invade the domestic market.

Large-scale integrated circuits and, of course, microprocessors, feature prominently in the new products, which include video recorders and home computers.

OFF-AIR RECORDING PROBLEM

The technicalities of video recording were ably described by speakers from the BBC, JVC (UK) Limited and Philips Electrical yet none had the answer to that important and intriguing question *is it legal to record TV material off the air*.

The nearest to an answer was the belief that the recording of short extracts from programmes is allowed provided the recordings are to be used for educational or private study purposes only.

Clearly Copyright and Performing Rights are major matters that will have to be decided quickly, certainly before the sales of domestic video equipment takes-off, as expected.

MICRO-CONTROL

An infrared remote control for TV receivers was described by an engineer from ITT Semiconductors. This is a fully digital pulse coding system providing up to 1,024 commands. The low power microcomputer incorporated permits the programming of TV viewing up to one week in advance. Beyond TV control, this system, it was claimed, is capable of many other control functions, in association with peripherals around the house.

A speaker from Intel Limited painted an exciting picture of the home of the future—run by a microcomputer of course. The catalogue of suggested functions was not new. Clearly manufacturers of chips are still kite flying. They, above all, need hosts of novel applications for their undoubted powerful and "intelligent" microprocessors. It's thinking up useful chores for these devices that is the *really* difficult part!

NO SINGLE MIND

The symposium revealed the interesting fact that experts are not of one mind concerning the best deployment of the microprocessor in home control systems.

Considering the cheapness of low power microprocessor chips, some held the view that most individual applications around the home should be run by a separate, independent, integral micro. Others favoured the "master" control approach with all peripherals tied into a central control computing unit.

These things will all come about — there's no doubt. Moving into a different scene, two fascinating developments in the radio field were described by research engineers from the BBC. Whether they will ever see the light of day seems problematical though.

One is the BBC Carfax Traffic Information Service. It involves a nationwide network of low power m.f. transmitters. A special low-cost receiver remains quiet until activated by the transmitter covering the area through which the motor vehicle is passing. This system is currently undergoing field trials.

RADIO OF THE FUTURE

The second development from the BBC seems even more futuristic, if viable at all. This is a scheme where broadcast radio signals would carry some form of identification or "data label". This information would be decoded by domestic radios of the future, and used in various ways. For example, it is suggested that digital logic and microprocessor techniques could be incorporated in radio receivers to operate the tuning (so dispensing with the traditional mechanical drive) and in addition display visually information regarding the station being received. An ambitious extension of the system is the proposition that Bar Codes could be printed in the Radio Times above each programme entry, and then by scanning this code with a Bar Code Pen attached to the receiver, the tuning would be automatically and accurately performed.

Citizen Band Radio seems a more likely bet when doing a spot of crystal gazing, and the speaker from Plessey was listened to with eager attention as he described a transmitter-receiver system based on his company's i.c.s which currently is being exported to certain countries where CB is "legit". The system described however is only of academic interest to citizens of the U.K., for it operates on 27MHz v.h.f. If we are lucky (?) enough to have CB, all the experts tell us it will operate somewhere higher, like u.h.f.

In all, twenty technical papers were delivered by specialists from industry and other bodies who, in the main, described work they were personally involved in.

The Symposium was another notable success for the principal organisers, SERT, who have established a fine tradition in arranging gatherings such as this dealing with technical matters of the moment.

Grumble-Grumble !

Why grumble about consumer goods prices in the UK? When Portugal goes to colour TV next year the average price of a colour set is expected to be £480. Experimental services on the PAL system will start in March 1980.

In East Germany where there are still no colour transmissions the cost of a medium-sized monochrome set is over £500 according to a recently returned visitor.

MOBILE PRINTER

A tiny electronic printer which can print pictures, text, maps and diagrams has been developed by English Numbering Machines. It will work in any position, even upside down, and as it is only 205 x 210 x 105mm in size it can easily be fitted in vehicles.

The police emergency services and the military are obvious "mobile" customers or with a keyboard it forms a useful low-cost printer terminal for general office use.

The machine is multi-function through a built-in microprocessor.

Author and script-writer Ted Willis and ex-TV broadcaster Peter Dimmock (now chief executive of BBC Enterprises) are among the seven new Fellowships awarded by the Royal Television Society.

BRIGHT SPARKS

The competition for "Young Engineer for Britain 1979" has had a record entry from over 300 youths of both sexes in the 14-19 age bracket. The best 40 projects will be judged at the national final on October 24 and 25 at the Wembley Centre. It is hoped that the Prince of Wales will present the awards.

The competition is sponsored by the Department of Industry as part of a programme to strengthen links between education and industry. It has been so successful that it has already been decided to hold another competition in 1980.

—ANALYSIS

OUR CROOKED WORLD

Security, in its broadest sense, must surely be today's biggest growth area in electronics. And I don't mean just the enormous annual expenditure on equipping armies, navies and air forces throughout the world.

The present-day menace is internal, the growth in crime, either crude as in the case of a bank robbery at the point of a gun, or sophisticated as in computer fraud. And on top of the increase in ordinary crime are the activities of the politically-motivated terrorists.

I was reminded of this by a recent announcement by Al Security of Cambridge of an order worth close on £1 million for some 100 Entry-Scan walk-through explosive detection systems which are to be installed at every one of the 72 operational nuclear reactors in the United States. The Entry-Scans will sniff each person passing through and detect the slightest whiff of explosives vapour on the body. They will be installed alongside existing personnel indentification, metal-scanning and radiation-level checking systems.

But electronic security is big business wherever you look, in warehouses, supermarkets, banks, industrial complexes, in art galleries and museums, increasingly in our own homes.

The great problem with all electronic sensors is that the more sensitive you make them the more likely it is that they will give false alarms. Maybe a fault in the right direction—better safe than sorry! But the police, for example, get very bitter about the time wasted on over-sensitive equipment when they find that the "intruder" detected by a doppler equipment is only the office cat.

So great ingenuity in recent years has been employed in systems which are "intelligent" in the sense of discriminating what is actually happening. Take a perimeter microwave "fence" with its invisible radio beam which triggers an alarm if it is interrupted by an intruder. By designing the antenna system to provide the right shaped beam it will ignore heavy rain or falling leaves, birds or small animals, but will respond to humans.

In microwave doppler systems used inside premises, the signals are analysed and no doppler change will activate the alarm unless it is fairly large and the object has moved some distance.

Infrared systems, which work by detecting the difference between the infrared radiation from a human body against the infrared background, may be arranged through their optical system to beam in a number of zones both vertically and horizontally so that an intruder may have to cross more than one zone before the alarm is triggered.

If you wonder why, when you have installed perimeter protection on the outside, you still need more of it inside, the answer is that the intruder at night may have secreted himself inside earlier in the day. These security specialists know so much about the habits of criminals that you might imagine that they had once been burglars' apprentices, but I am told not necessarily so. **Brian G. Peck.**

At The BAZAAR

ANYONE visiting "The Great British Electronics Bazaar" at Alexandra Palace, London (June 28-30), expecting in the words of the organisers "an amateur show of shows, a bazaar of bazaars", was in for a mild disappointment.

If you were among the fortunate ones who managed to find the public transport service running or came by car, then the disappointment of finding the Grand Hall sparsely populated with stands was not so great as the people who, if they survived, managed to walk to the summit of "Coronary Hill" as it will now be known by many visitors.

Although the shoulder-to-shoulder atmosphere usually associated with bazaars was missing, the show was certainly hustling and bubbling on the opening day. Appropriately opened by the organiser's thirteen-year-old son it seemed to set the scene for the exhibition with most visitors in the younger generation age group.

Practically anything remotely connected with electronics was being sold from resistors and cases to professional test equipment to colour television sets; not forgetting publications.

Microprocessors were in prominence with many stands showing and selling complete home computers. Among them was Acorn Computers who demonstrated their microcomputer system which at £65·00 (excluding VAT) for their basic kit must be one of the cheapest on the market. This does not include controllers or memory modules.

From industry, Fluke and Gould Advance exhibited their lower price range of instruments and both indicated reasonable sales.

Two stands which reported very good response and sales were Bi-Pak Semiconductors, who couldn't sell their bargain packs of assorted components quick enough, and OK Machine & Tool (UK) Limited whose wares included wire wrapping equipment, quality hand tools, screwdrivers, ribbon cable, i.c. sockets and breadboarding systems. Also doing brisk business selling television sets at £50·00 a time was West Midland TV Trade Sales. They claimed that they had sold over £1,000 worth of sets in the first morning.

For our part, EVERYDAY ELECTRONICS had many past, current and future projects on display. The theme of our display was "Electronics in the Home" and we had working models mounted on a house plan showing possible applications in the home, garden and car.

Judging from the remarks from visitors to our stand most people thought we had put on a good show and complimented us on our efforts. We also received a favourable response to our lecture delivered by Owen Bishop entitled *"Getting Started In Electronics Construction"*.

Summarising on the show, to use the word "Great" in the title with the absence of so many possible exhibitors was, in our opinion, wrong. As also was the practice of numbering the stands up to 355 when there were only approximately 62 exhibitors and only approximately 90 stands shown on the plan in the catalogue.

Likewise it seemed wrong to charge an entrance fee to the *sponsored* lectures, particularly as the show was aimed at the amateur and was not run on a professional seminar basis where the fee usually includes papers which are kept by the participants.

Apart from the virtual inaccessibility by public transport, lack of the big names from industry and public services such as the P.O. the show was a Grand effort.

Let's hope that with a little more planning next year's show will be a truly Great British Electronics Bazaar!

RUMMAGING AROUND

with Keith Cadbury

IT would seem fair to assume that most electronics afficianados are, by the very nature of their hobby, quite practically minded: able and equipped to tackle many other constructional tasks around the home. It therefore follows that they will have stored various miscellaneous bits and pieces that "might come in useful one day."

COLLECTORS ITEMS

The writer's collection of junk is contained in thirty-three 2 litre ice cream cartons, a chest of drawers, two shelf units, 25 "Household" matchboxes, 14 Cadbury's (who else?) *Smash* tins, two large tool boxes, seven cardboard boxes and four carrier bags. The stock includes seven small electric motors from cassette recorders; a few odd bits of *Mecanno;* some empty colour slide boxes; and various small offcuts of chipboard.

While recently "checking stock" (looking for inspiration for a project that could be built with existing junk), the thought occurred that with these aforementioned items it might be possible to make some sort of miniature drill for making holes in printed circuit boards.

To date the writer has drilled p.c.b.s with a Black & Decker "Holgun," which is a very slow, geared-down, extra heavy duty electric drill intended for use with masonry drill bits, by builders and shopfitters. Not ideal for tiny delicate electronic work, but junk shop buyers can't be choosers.

The main thing against such a weapon, apart from its unwieldiness, is the screaming of the motor and gears. To protect one's ears during long drilling sessions, one has to wear headphones as earpads.

The one millimetre drill bit was held in the monster by a small extension chuck, called an "Eclipse No. 121 Pin Vice." This is about 6mm diameter, 75mm long, with a miniature chuck at one end. The other end was clamped into the large chuck on the Black & Decker. These "Pin Vices" can be purchased from decent tool shops for under £2.

STICKY PROBLEM

A method of fixing the pin vice to a cassette motor had to be found, but the wonders of modern science solved the problem without recourse to once more calling on an aquaintance who owns a lathe, and rues the day he met the writer!

For some time now Cyanoacrylate adhesive has been a useful item to include on a workbench for all sorts of repair and constructional jobs. *Superglue,* as one brand is named, has once again proved its worth as the means of fixing the miniature chuck to the end of a cassette motor. To assist the super glue, by offering more surface for the adhesive to work on, a circular groove was "turned" into the top of the pulley on the motor spindle.

This was very simple, albeit slow, to effect, by the simple expedient of holding the end of a needle file to the pulley, whilst rotating the motor under power. So the obvious part to build first is the Power Supply.

MINIATURE ELECTRIC DRILL AND STAND

POWER SUPPLY

During experiments conducted with seven different cassette motors, pumping three times the recommend voltage in has resulted in very little increase in speed, but an incredible reinforcement of power. Therefore a transformer giving 12 volts at 200mA was used, with the usual 4 × 1N4001 rectifier bridge, and a small capacitor of about 680μF (25V), to provide a d.c. output of about 17 volts. See Fig. 1.

Any capacitor of about 330μF or more, should suffice, so long as the working voltage is *at least* 25 volts d.c.

Smoothing is not critical with such a simple supply, and quite possibly a slight ripple in the d.c. current assists the motor in starting under load.

The completed power supply unit was housed in a plastic container originally used for *Agfacolour* slides, but any sturdy plastic box of suitable size would be acceptable.

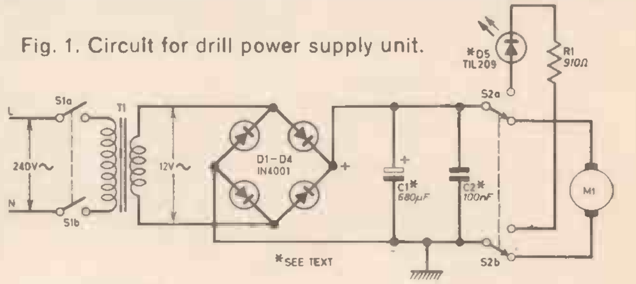
It is the writer's practice to always include a small d.c. power socket to any new p.s.u.s constructed for use on the bench, so that many different voltages are available for various experiments and repair jobs. If you feel this is a good idea, then perhaps extra capacitance would render the supply more suitable for occasional alternative use. And if sensitive circuits are likely to be plugged in, a 100nF capacitor across the output will reduce mains hum with audio applications. An inexpensive disc type, of suitable voltage rating, will suffice.

Having built the p.s.u. the cassette motor can be connected.

There will be more motor noise than the usual six or seven and-a-half volts produces, but the extra torque that is generated has to be felt to be believed. A drop of oil to the bearings is a good idea, in view of the extra wear and tear that may be expected.

Possibly some cassette motors are unsuitable for use with 17 volts, but the seven 6V types tested by the writer and found O.K. include motors by Toshiba, Sankyo and Matsushita. Various other motors tested were not marked, but came from scrapped recorders that included Waltham, Monatone, Swan and Hong Kong DeLuxe (!)

Fig. 1. Circuit for drill power supply unit.

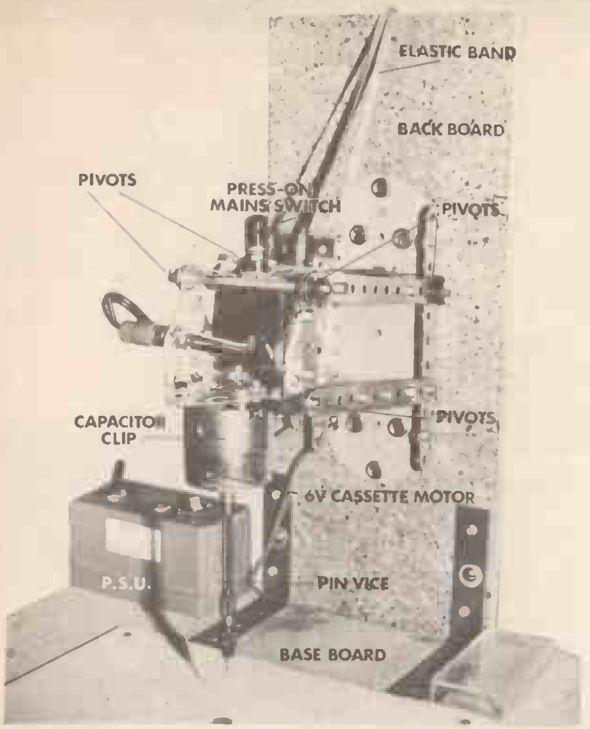


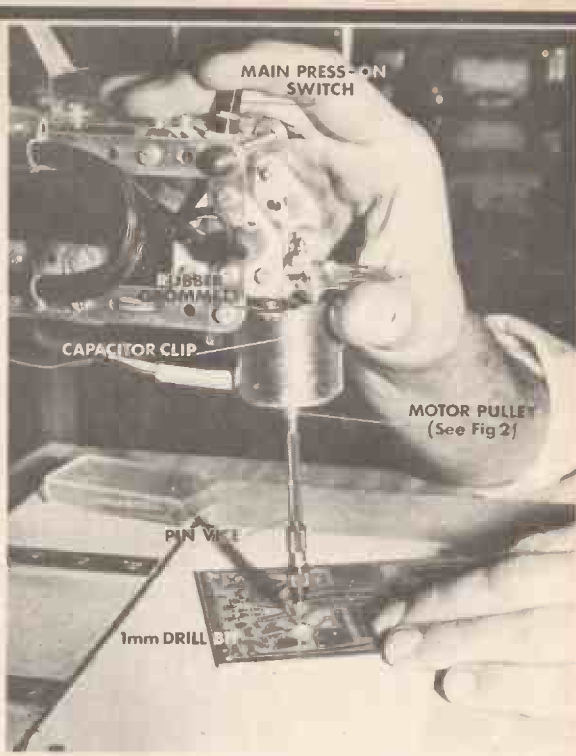
TURNING THE GROOVE

Hold the motor by its outer casing firmly in one hand, and after connecting the voltage supply apply the end of a suitable needle file to the flat top of the pulley. Before commencing "turning" you will have made sure that the grub screws that hold the pulley to the motor spindle are tight.

Cut a circular groove into the end of the pulley, of a diameter and depth suitable to accept the end of the hollow shank on the vice pin. A snug fit is not the express intention here, but if such is possible with the tools you have to hand, all the better. The groove will take some time—twenty minutes or so—to cut to about 2mm depth, but the deeper the groove, the more sturdy the finished result.

When you are satisfied with the depth and width of the groove,





switch off the motor and stand it on the bench, pulley uppermost. Apply two or three drops of *Superglue* to the groove, taking special care not to get glue into the bearings of the motor. Now press the shank of the pin vice into the groove, and rotate the pulley slowly to ensure a true fit. See Fig. 2. The importance of a neat groove now becomes apparent—with too much sideways play, the job of attaining accurate concentric placement becomes more difficult.

Apply downwards pressure, for ten seconds. If you have not used Cyanoacrylate glue before, be *very* careful. Ten seconds is all it takes to secure permanently practically anything to anything. Including human skin.

Perhaps the writer was very lucky, but his second attempt was so successful that when the motor is revolving, the pin vice is absolutely spot centre, with no vibration at all. The only slight anomaly is that the chuck jaws do not appear to be perfectly true, with the result that a 1mm drill bit seems to oscillate over about a 1mm circle.

Check that the drill is rotating in the proper direction for the bit to "screw in", if necessary reversing the connections from the power supply unit. If you prefer to use the drill handheld, you are now ready to go, but for real ease of operation, a simple drill stand is recommended. A stand will also enable boards to be drilled at great speed.

DRILL STAND

A stand can easily be constructed from *Meccano*, although metalworkers will no doubt be able to

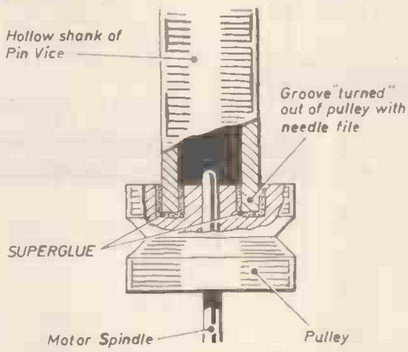


Fig. 2. Section through motor drive pulley and pin vice.

improve upon the basic principal, with a more professional-looking result.

A clip intended for vertical mounting of capacitors is used for clamping the drill body to the *Meccano* mechanism. Various diameters are available.

The clip should be bolted to the stand through a couple of rubber grommets, to avoid transmission of vibration and motor noise.

Illustrations show the idea of the drill stand, which can be ammended according to *Meccano* or other materials available.

A simple press button is needed, placed so that it can be operated by the hand that controls the downward motion of the drill. In the writer's case, an l.e.d., supplied through a 910 ohm resistor, was incorporated so that indication is given when the transformer is switched on. As a double-pole change-over press switch was to hand, the l.e.d. has been wired to glow only when the motor is not rotating.

AUTO LIFT DEVICE

An elastic band or coil spring is hooked between the top of the stand back board and the drill, so that the drill automatically rises when not held to the p.c.b.

The eight pivots of the stand are slightly oiled to assist in smooth operation, and the complete mechanism is mounted firmly to the back board. The back board should be screwed to the base board through four flat metal shelf brackets.

Once the whole device is constructed, lower the drill, with drill bit inserted, to the board, to mark where it touches the base board. Now with a normal size drill and ¼ inch bit, drill right through the base board, using the small mark made by the 1mm bit as the centre. This large hole ensures that the miniature bit is not damaged, and also allows swarf from p.c.b.s being drilled to fall away.

The base board should be mounted on four rubber feet.

IN USE

The finished drill in use is quick and surprisingly powerful. The slight deviation of the chuck jaws mentioned earlier is easily overcome by pressing the bit to the p.c.b. before operating the press button. After a little practice, the amount of pressure to apply is determined.

The over-run cassette motor may become warm in use, but the prototype was subjected to six hours' continuous bench test under torsion, with no ill effects other than an increase in temperature.

RADIO WORLD

By Pat Hawker, G3VA

CB band-wagon

As someone who has written in favour of CB (Citizen's Band) radio for a period extending over at least 15 years, I must admit to being disturbed by some of the current, often ill-informed, lobbying on its behalf. There are many signs that much of the present pressure comes directly from industry concerned (as it has every right to be) far more with the value of the potential market for equipment than with the social benefits so confidently predicted.

Then there is the curious but widespread confusion between CB two-way radio and local community broadcasting, two totally different subjects except that both seek a share of the radio spectrum. There is also the belief that the opposition to CB stems from an unholy alliance of the Home Office Radio Regulatory Department and licensed "Hams".

It has always been my experience that there is no clear-cut consensus of opinion on CB within the amateur-radio ranks, and that indeed very many amateurs would favour CB provided that it could be kept quite separate from their own hobby and was so organised that it would be unlikely to degenerate rapidly into an uncontrolled, poorly organised imitation of "ham radio" lacking the self-discipline and self-policing that stems from the desire not to lose a licence that has involved passing examinations.

In other words, there is undoubtedly an extremely strong case for extending the use of two-way radio systems to the public for mobile use, "companionship" and for the original concept of a low-priority communications service. But not, I suggest, as a service for those who have a real interest in the technical development of two-way radio.

The hobbyist should instead be encouraged into amateur radio, if necessary by introducing novice or beginner licences with a built-in incentive to progress to the more advanced licences. Unfortunately few countries have succeeded in setting up CB in such way that this distinction is made.

CB can (and does in some countries) work very well indeed; it can unfortunately also work badly, with hobbyists for instance using high-power linear amplifiers and showing no consideration for other users. It has all become a political argument with little concern for what CB is all about.

Geneva Plan

For many years the broadcasters in the UK have plugged away about the advantages of v.h.f./f.m. radio compared with m.f./a.m. (and not said overmuch about the few disadvantages of v.h.f./f.m.) but all to little avail. At any given time, something like over 80 per cent of the radio audience is still likely to be listening on medium or long waves, less than 20 per cent on v.h.f./f.m. Indeed with the BBC wavelength reshuffle last November, it almost seemed as though they had given up the struggle and accepted that listeners needed to use both systems.

Yet the problem of providing adequate coverage on m.f. from about an hour before sunset to an hour or so after sunrise seems bound to grow steadily more intractable during the next few years. The disastrous decision of the 1977 ITU Geneva conference to give every country what it had asked for, in effect abandoning any real attempt at planning for minimum interference, has still to make felt its full impact.

Many of the stations now registered by that Conference have yet to be built and similarly many of the power increases are still in the pipeline. So while good daylight coverage on m.f. is relatively easy, the situation from dusk to dawn (which in the UK extends up to almost 18 hours out of 24 in mid-winter) seems bound to grow steadily worse.

It is no good blaming any single broadcasting organisation or any single country: it is sheer collective madness. In effect the radio lemmings are rushing headlong over a cliff of intolerable m.f. interference. But will anyone ever persuade that 80 per cent of the audience that they will be forced to use v.h.f./f.m. to obtain interference-free reception?

Super Sets

In the July issue, Adrian Hope in the *For Your Entertainment* column drew attention to the work of that great inventor of radio receiving systems, Howard Armstrong, and mentioned his development in 1921 of the high-gain "super-regenerative detector". Though he added that this is today forgotten by all but the most avid radio enthusiasts.

While this is certainly true, I have been interested to find that a New Zealand radio amateur, Nat Bradley, ZL3VN, has been doing a considerable amount of experimental work to see if with modern components and devices there may not still be a role for the very simple super-regenerative receivers, particularly on v.h.f.

His conclusion was that this type of receiver remains a fascinating and unnecessarily maligned device. While almost all the circuits published in hobby magazines during the past 30 years or so have been of the "self-quenched" form of super-regen' detector, the New Zealander has shown convincingly that much improved results can be achieved using separately quenched detectors, that is to say where a separate oscillator is used to provide the supersonic quenching frequency that allows the regenerative detector to work at enormous gain.

He has also discovered that a sawtooth quenching waveform with slow-rise and fast-decay times provides superior results.

Provided that care is taken that super-regen' receivers do not radiate interference (and this is far less a problem with f.e.t. devices than used to be the case with valve super-regen' receivers), it is perhaps high time to take a fresh look at Armstrong's miracle system of 1921. Like all other forms of direct-conversion receiver they are much easier to build at home than high-performance superhet receivers.

Coloured Sounds

If I were a retailer of hi-fi music centres, or sound-reinforcement installations, or a designer of surround-sound systems, I would have one terrible oath, reserved strictly for such occasions as dropping a 100-watt amplifier on my toe, but never, never to be uttered in the hearing of potential customers: it would be "environmental acoustics".

Many years of straining my ears to catch announcements in railway stations, swimming pools, air displays or listening intently (in just the correct position) for the subtle effects of surround-sound have long convinced me that the sounds emanating from even the best amplifiers and loudspeakers can be hopelessly coloured by the local acoustics. Conversely medium-quality installations can provide very acceptable results when they have the room or hall going for them.

It is all very well the manufacturers providing us with response curves measured in an anechoic chamber. Who actually listens in such places?

Major changes in the quality of reproduced sound can be (and are) introduced by the acoustics of the studio and the listening room. But who would learn this from most hi-fi advertisements in the non-technical press?

NICKEL CADMIUM BATTERY MONITOR

By A. J. Adamson

RECHARGEABLE nickel cadmium batteries are now very widely used in such equipment as cassette recorders, radios, drills, etc. They are however expensive, and to ensure a reasonably long life should be treated with care.

This in simple terms means that the cells, during their normal working life should never be allowed to discharge beyond their "end point" voltage. Basically this voltage is a "once reached never to return" state, in which it is difficult to recharge the battery correctly.

In most cases however the batteries can still be recharged, but their life is drastically shortened.

END POINT VOLTAGE

The end point voltage is indicated by the cell voltage falling to 1·1V in the case of low discharge rates, and about 1V in the case of heavy discharges. Normally however 1·1V is regarded as the norm. Unfortunately, the cell voltage varies by only 0·1V over about 80 per cent of its discharge. The circuit here however is sensitive enough to detect the end point voltage from the falling cell voltage.

When incorporated in Ni-Cd operated equipment this simple circuit gives an indication that the batteries need re-charging.

Table 1. Component Values.

Number of Cells	Battery Voltage	Zener Voltage	Resistor Values (kilohms)[3] R1	R2	R3	R4
[1]4	5·0	3·9[2]	0·27	10	82	0·68
5	6·25	5·1[2]	0·27	6·8	82	0·82
6	7·5	5·6	0·68	15	82	1·2
7	8·75	5·6	1·2	18	47	1·5
8	10·0	5·6	1·5	39	68	1·8
9	11·25	5·6	2·2	43	56	2·2
10	12·5	5·6	2·7	47	47	2·2

Notes: 1. Circuit is at its limit of range.
2. Lower Zener voltage needed despite better temperature stability of 5·6V Zener.
3. All resistors are ¼W carbon ±5%.

CIRCUIT DESCRIPTION

The full circuit for the Nickel Cadmium Battery Monitor is shown in Fig. 1. A number of components have not been given values, these will be explained later. Basically the circuit compares the battery voltage with a reference voltage indicating this on a light-emitting diode.

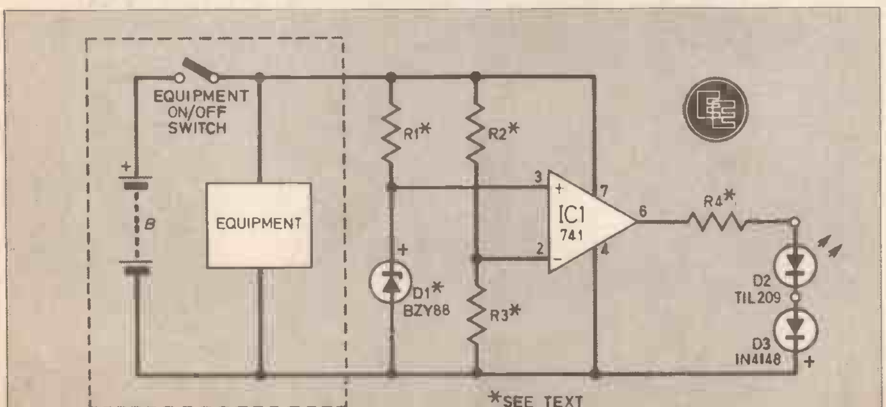
The integrated circuit, IC1, is a 741 operational amplifier and is used as a differential amplifier. The non-inverting input, pin 3 is clamped at a reference voltage provided by the Zener diode D1.

The inverting input, pin 2 follows a fixed fraction of the battery voltage, provided by the potential divider consisting of R2 and R3. The output, pin 6 drives an l.e.d. via a current limiting resistor R4.

When the battery is fully charged, pin 2 is positive with respect to the reference voltage on pin 3. The output of the i.c. is thus low and the l.e.d. unlit. As the battery discharges, the voltage on pin 2 falls until it becomes negative with respect to the voltage on pin 3. The output of the i.c. now goes high illuminating the l.e.d. Thus a warning is given that the battery is in need of recharging.

The values of R2 and R3 are chosen so that switch-on occurs when the battery end point voltage is reached.

Fig. 1. Complete circuit diagram of the Nicad Battery Monitor.



COMPONENTS

Resistors
R1-4 See text (Table 1)

Semiconductors
IC1 741 op-amp
D1 BZY88C Zener diode (See text for voltage)
D2 TIL209 red light emitting diode
D3 1N4148 silicon

Miscellaneous
Stripboard, 0·1 inch matrix 8 strips × 8 holes; i.c. socket if required; connecting wire.

£1 Approx. cost Guidance only

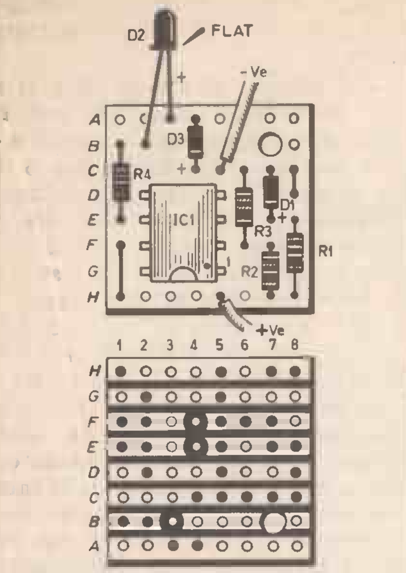


Fig. 2. Stripboard layout of the unit.

COMPONENTS

The circuit can be adjusted to monitor batteries with various nominal output voltages, using from four to ten cells.

Values for the components unmarked on the circuit diagram are chosen from the figures in Table 1. Thus for a battery with a voltage of 8·75V the components values in line four are used.

CONSTRUCTION

The circuit is very easy to construct and should present no difficulty even for beginners. All the components are mounted on a small piece of 0·1 inch matrix stripboard, having 8 strips by 8 holes as shown in Fig. 2.

Remember to identify the correct numbering of the i.c. pins and also note the correct orientation of the l.e.d. A socket can be used for ICI but is not a necessity.

No on/off switch is required as the circuit is switched on and off by the switch in the equipment.

MOUNTING IN EQUIPMENT

The circuit has been designed specifically for mounting inside existing equipment. The first thing to do therefore is to find some space inside where the board can be fitted, and with no possibility of coming into contact with any metal work or other components.

The two connecting wires can then be connected into the equipment circuit. The wire from point *C*5 should be connected to the negative line of the equipment, while that from point *H*5 should be connected to the positive line after the equipment's on/off switch.

A small hole should also be drilled in a convenient position to allow the l.e.d. to be mounted. For this it might be necessary to extend the leads of the l.e.d. by lengths of connecting wire.

IN USE

When the equipment is first switched on, after an initial flash from the l.e.d. as the capacitors inside the equipment charge up, the l.e.d. should remain off, providing, of course, the battery is fully charged. If the l.e.d. remains illuminated then there is an error in the wiring and should be corrected before continuing.


The prototype Nickel Cadmium Battery Monitor built on a small printed circuit board.

To give a rough check on the operation of the circuit, connect a low value potentiometer, say 100 ohms across the on/off switch With the potentiometer set to its lowest value, and with the equipment switched on all should function correctly, with the l.e.d. remaining off.

Now increase the value of the potentiometer slowly. After a certain point the l.e.d. should suddenly come on. As the potentiometer is increased further, the l.e.d. should slowly fade and eventually go out as the voltage to the equipment falls. If this test is satisfactory then the circuit is functioning correctly.

For a very small outlay this circuit protects those very expensive Ni-Cd batteries against over discharge, which if continued for any length of time brings about rapid failure of the batteries.

The circuit takes about 10mA, and so should have negligible effect on the life of the batteries. ⌑

JACK PLUG & FAMILY... BY DOUG BAKER

SQUARE one FOR BEGINNERS

THE majority of the simpler battery operated projects described in EVERYDAY ELECTRONICS are built according to a fairly standard pattern. Obviously there are variations in detail, since alternative items of electronic "hardware" are available from suppliers. The following information provides a simple general outline of what is involved in putting together an electronic project.

MOUNTING THE COMPONENTS

Electronic circuits are built by mounting the individual components upon a piece of non-conductive board, usually of a plastics material. (There are several different types of board used for this purpose. But for the present we can ignore details and discuss in general terms.)

The leads of the components are passed through holes in the board and soldered connections are made on the underside surface. See Fig. 1.

HOUSING THE ASSEMBLY

When completed, the circuit assembly is usually housed in a plastics or metal box. This box will also accommodate the layer type dry battery which powers the unit.

The board is made secure by a couple of small screws and nuts, for example No.6. BA or similar fixing. Care has to be taken that the screws do not make contact with "live" parts of the circuit board. Spacers can be fitted to the screws to provide clearance between the board and the box. This is especially advised where the box is made of metal. See Fig. 2.

The entire circuit of a project may be assembled on the one board. However, it is more usual for a few larger components, including those that have some mechanical function—such as volume controls and on/off switches—to be mounted directly on the box itself. Likewise, if a loudspeaker is involved this will probably be mounted on the top panel or lid.

The box thus must be drilled to receive such components before the circuit board is fitted.

Operating controls are usually variable resistors or "potentiometers". They have a standard diameter spindle and threaded bush and are secured to the case by a lock nut.

Switches, rotary or toggle, may also have threaded bushes, but some types are secured by screws, and may require a slot for the moving part.

Drilling and cutting out is not difficult with plastic or aluminium cases. The larger holes can be easily made by enlarging a drilled pilot hole with a round "rat tail" file. Rectangular holes or slots can be made similarly but using a flat file.

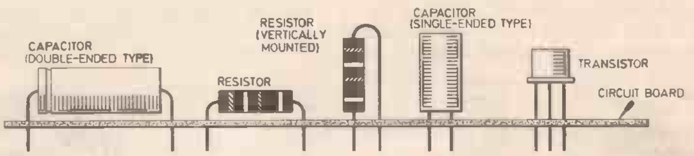


Fig. 1. Side view of circuit board showing component leads prior to soldering and clipping.

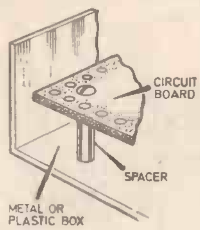


Fig. 2. Isolation of circuit board from case by "spacer".

Other materials, such as die cast aluminium and steel, do really need the proper tools.

WIRING UP

When the circuit board and all other components have been mounted, the final wiring up between circuit board and the case-mounted parts must be carried out.

Sometimes it is simpler to do this wiring before the parts are installed, but make sure the length of wire is adequate for the purpose, without any undue stretching. A small amount of slack is advisable and this allows the interconnecting leads to be "dressed" neatly when all other work is completed.

In general, arrange for long leads to travel (run) in straight lines, forming sharp angles when changing direction. This makes for a more attractive appearance than if wires "snake" all over the place.

The battery should be secured to the case with a metal clip or a plastic strap. It must not be allowed to float freely within the case. The proper type of battery connector must be fitted to the terminals. Ensure the leads to the battery are sufficiently long to permit battery removal without difficulty or damage to connections.

CONNECTING WIRE

Connecting wire is available in many types. For most general electronic work plastic-covered tinned-copper wire is ideal. This is available in two forms:

1. Solid (or single) conductor
2. Stranded conductor

The solid conductor allows neat wiring to be made, but because of its rigidity has disadvantages where the equipment may be subject to vibration. It should not be used where a flexible connection is needed, for example, the leads to a battery.

Stranded wire being flexible is easy to use, but it is important to examine the bared end before soldering in position. If necessary, twist the strands together to avoid leaving any "whiskers" which could make contact with other nearby parts of the circuit.

Wire is specified as number of strands/strand diameter in mm. The following wires are suitable for most EE projects.

Solid conductor: 1/0·6mm
Stranded conductor: 7/0·2mm

These wires are supplied in a variety of plastic-covering colours. It is a good idea to have a small selection of colours at hand, and to use these in some specific and preferably logical manner. For example: red covered wire for the positive supply line, black for negative, and possibly green or blue for signal circuits.

The essential point is to be consistent in the use of colours throughout the project. The colours will then prove of value whenever checking over the circuit at a later time. This is particularly so in the case of large and complex projects.

BEGIN HERE

The basic principles of electronic circuits will be dealt with in our forthcoming series ***Teach-In 80***. This 12-Part Series will commence in the October Issue of EE.

Those who are new to electronics and who wish to study this subject at home should seize this opportunity. Naturally it is vital to start at the beginning—so remember ***Teach-In 80 Part One October issue.***

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COMPONENTS AND PARTS

CAT. No.	DESCRIPTION	PRICE
276–032	LED	4 for 69p
276–033	LED	2 for 48p
276–034	LED	2 for 59p
276–142	Infra-Red Emitter Detector Pair	£1.37
277–1003	12V DC Automotive Digital Clock Module	£17.52
276–9110	6 pin edge connector for 277–1003	40p
276–1373	Power Transistor Mounting Hardware	50p
276–1363	TO–220 Heat Sink	60p
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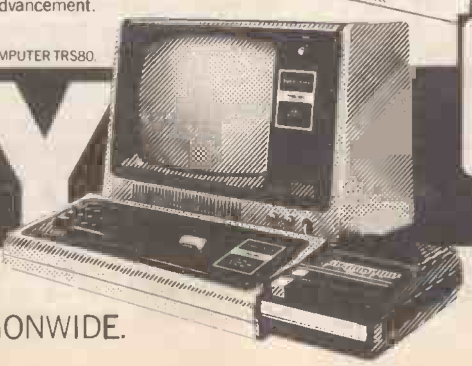

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By Dave Barrington

Catalogue and VAT

This month we should like to add our congratulations to Stevenson Electronic Components on their approach to the Government news of the increase in the dreaded value added tax (VAT!).

On hearing the news of the 15 per cent rate, they immediately decided to absorb these increases and announced that despite this all prices quoted in their catalogue would still remain valid until 31 April 1980. *This is indeed good news for our readers.*

On the subject of catalogues. Their new 1979/80 Components catalogue consists of 80 pages listing over 2500 "off-the-shelf" stock items.

Over 30 pages are devoted to semiconductor / microprocessor devices, including some audio circuits. Also listed are tools, cases, printed circuit board materials and cables. Quoted amongst the cables is the light-duty 10/0·1 cable called-up in the *Low Cost Metal Locator* published in our June issue which some readers seem to have had difficulty in obtaining.

Free copies of the Stevenson Components Catalogue can be obtained from Stevenson, Dept EE, 76 College Road, Bromley, Kent, BR1 3BR.

Solar Cell

Any alternative sources of energy are big news at the moment and fresh ideas for avenues of possible new approaches or aids in exploiting these needs are eagerly being sought by research establishments worldwide.

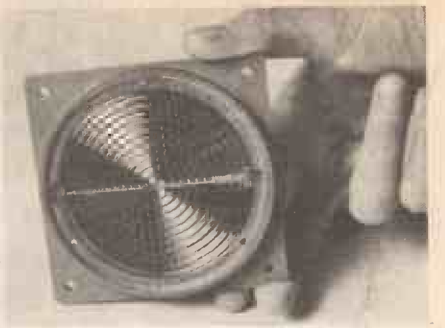
One area where schools, colleges, universities and even the dedicated amateur can take an active part is in the exploration of "solar power".

A new product that will certainly interest anyone engaged in solar power research has just been announced by Ferranti Electronics.

They have developed and produced a silicon solar cell, designated ESC3 series, measuring only 76mm in diameter capable of producing 0·9A at 0·5V under good sunlight conditions.

Physical protection is provided by a tough moulded case and by a Fresnel lens which also acts as a light collector. The output voltage is taken from metal pins on the rear of the case. Accidental short circuiting of the output will not damage the cell, also any number of cells can be arranged in series/parallel combinations to provide increased output.

Readers requiring further information should contact Ferranti Electronics Ltd., at Dept EE, Fields New Road, Chadderton, Oldham, Lancs., OL9 8NP.



New silicon solar cell from Ferranti

CONSTRUCTIONAL PROJECTS

EE70 Reflex Loudspeaker

The *EE70* is a high quality enclosure design and being a costly project we suggest you use only top grade components throughout.

For those readers who do not wish to shop around for their components a complete kit of parts is available from Wilmslow Audio for the sum of £150 (add £5 for p & p and insurance). This does not include the woodwork which will have to be purchased from your local timber merchant.

Referring back the the *EE20 Loudspeaker* (July '79), please note that the front and back frames are recessed within the case so that the outer surfaces of the grille panel and back panel will be flush with the edges of the case. The published diagrams are correct.

Varicap Personal MW Radio

The only component that is likely to prove troublesome to obtain for the *Varicap Personal MW Radio* is the varicap diode D4, type MVAM115. Todate, we have only been able to locate two sources of supply and these are: Maplin Electronics and Watford Electronics.

Particular care should be taken when soldering the varicap and the integrated circuit on the circuit board as they are susceptible to heat. We recommend that you use a heatsink when carrying out this operation.

We understand that this month, Chromasonic Electronics are offering the ZN414 radio i.c. at a special discount. The price for two chips is £1·25, including VAT and postage, and can be obtained from Chromasonic Electronics, Dept EE, 56 Fortis Green Road, Muswell Hill, London, N10 3HN.

Chaser Light

The *Chaser Light* project should be very popular and only a couple of components require further mention.

The thyristors (CSR) devices can be any types rated at or above 400V, 5A. If the unit is required to drive greater than the specified loads then obviously the thyristors will have to be uprated.

As the mounting tabs are internally connected to the anodes, it is most important to use mica washers and insulating bushes. We recommend heatsink compound when mounting the thyristors. These items are sold by most advertisers of semiconductors.

Be sure to use a heavy duty toggle switch for the mains on/off switch.

Doing It Digitally

In this months article for *Doing It Digitally* there is an experimental circuit for a "Digital Thermometer".

Looking at this circuit we can see that many readers may have difficulty in obtaining the specified thermistor. This is a Siemens type rated at 1 kilohm at 20°C and the only supplier we have been able to locate is Electrovalue.

However, although we have not tried them, the 1·5 to 2 kilohm range at 25°C seem to be fairly common and we see no reason why one of these should not be used.

Simple Transistor Tester

The meter used in our model of the *Simple Transistor Tester* was one of the battery/level indicator type which are stocked by most component suppliers.

Apart from the meter the rest of the components for this project should be readily available.

The *Nickel Cadmium Battery Monitor* and this month's *Mini Module—Low Power Audio Amplifier* use standard easy to purchase components and no difficulties are expected to be encountered with these projects.

VAT

Due to the recent change of VAT rates readers are advised to check prices in advertisements before ordering any components.

CB FOR UK?

By F. C. Judd

A governmental decision concerning the legalising of two-way radio communication between members of the public is expected in the coming months.

This article discusses impartially the advantages and disadvantages of Citizens Band Radio.

IF you have not heard about "CB" it means "citizens' band" which is the facility of two-way communication by radio transmission and reception by any member of the public at large. It is allowed in many countries but *not* in the UK where the use of radio transmitters in any part of the recognised radio frequency spectrum, except by specific and Home Office licenced services and users is positively illegal. *At present there is no frequency allocation and no licence available in the UK for any so called CB equipment.*

SPECULATION AND THE LAW

There is of course much speculation about CB radio being allowed but this depends entirely on whether the present or any future government in power can be moved sufficiently by demand from (*a*) the public as a whole, (*b*) the one or two existing CB pressure groups and (*c*) large commercial interests, to persuade the Home Office who have full control over the issue of all radio transmitting licences, to change their present dogmatic and negative attitude toward citizens band radio.

That is the situation at the moment and the several thousand who are at present operating CB transmitters in the UK are breaking the law and therefore run the risk of prosecution for doing so. The equipment these unlicensed operators are using is mostly for 27MHz (used for CB in the USA and other countries) and is causing widespread and serious interference to other essential services as well as to the licensed users this frequency is allocated to, namely the radio controlled model enthusiasts, many of whom have already suffered the loss of expensive model aircraft and control equipment.

These illegal operators may well be assuming that by sheer weight of numbers they will force the issue of legalising CB as has happened in Australia. This procedure is however not supported by existing and ostensibly genuine advocates of CB such as the Citizens Band Association.

THE BENEFITS OF CB

There are many more "for" CB than there are "against" of course; but on the other hand the valid *reasons* for allowing CB radio are more than equalised, if not completely outweighed, by reasons for *not* permitting its use in the UK.

The uses for CB, other than a means of purely social chit-chat and contact, are really rather limited. *Most are already adequately and efficiently catered for by other services.* However, the benefits of CB according to the CB Association and others are as follows. Based on studies by this association and the National Electronics Council in this country it is suggested that some 2,000 lives a year would be saved on the roads (in the UK) thus representing a monetary saving of £100,000,000 this being based on an estimate by the Road Research Laboratory of £50,000 per fatal accident.

FUEL SAVING

CB, they say, would also save up to 2·5 per cent nationwide on motor fuel by preventing wasted journeys. Further claims are the creation of some 15,000 new jobs and a licence and VAT revenue of around £10,000,000 per annum. We would of course have the use of CB for rescue work communication, when people get trapped in snow drifts in winter, or by floods, or on mountains or even adrift in pleasure boats as well as for large scale disasters *although these are areas already well catered for by existing and properly organised emergency communication services with trained operating personel.*

CB could and probably would be used extensively by business people and by employers to employees working at distances other than across the office or factory floor. The more "public" users of CB would presumably be expected to give way on frequency channels in use for any of the above. But would they?

RULES AND CODES OF PRACTISE

On paper the various "benefits" to be derived from CB radio may seem attractive and there is no doubt that lives might be saved by prompt and let it be underlined, efficient and disciplined communication, which means there must be rules and codes of practice.

This appears not to have been thought of by the advocates of CB. If everyone were allowed to drive a vehicle on the roads in a completely random fashion, ignoring all the rules, the result would be utter chaos. Free and random use of a very narrow band of radio frequencies without regard to others and without some form of disciplined operating could reduce all attempts at communication to virtually nil.

This is the reason why International agreements on codes of practice and frequency allocation etc, have to be made and why control over the various radio communication services within any country has to be maintained by an appointed authority.

OPERATING RANGE

Communication ranges with CB would normally be very limited, probably to a few miles unless, as is happening in some countries, very high power and large high gain aerials were used, albeit illegally. Since the band of frequencies allowed for CB would be very small indeed there would be only sufficient space for a limited number of stations to operate without interference to each other at any one time, even with the use of narrow band frequency modulation.

CB equipment will not, as the CB advocates might lead one to believe, be all low power mobile sets, that is used in vehicles or as small hand-held sets (walkie-talkies). There would be fixed stations having the advantage of high beam aerials and many would resort to the use of power in excess of that allowed.

TYPE APPROVED

All equipment intended for CB transmitting would certainly have to be *type approved* as is virtually all equipment used by all other recognised and licensed services. CB equipment which will be used by millions of people without technical knowledge would have to comply with tight specifications of performance with regard to frequency stability and power output and non-radiation on any frequency outside the allocated band, for example, harmonics which could cause interference to other services on other frequencies.

This is probably the most important requirement of all because any old home made or cheap jack manufactured CB sets would be potent sources of high level interference. *In the USA last year there were over 1,000,000 cases of television reception interference due to CB activity.*

THE PROBLEMS WITH CB

If CB could be properly controlled by continuous monitoring, if the use of type-approved equipment only could be enforced and maintained, if swift and positive identification of all users licensed or otherwise could be established, if all forms of abuse could be kept down to an acceptable minimum, then CB in the UK might be operationally viable and become a minor asset to the public.

RADIO VANDALS

The use of CB radio for criminal and subversive activity might not amount to much, it would be too public a medium for communication by those who for one reason or another require secrecy. But what of the cranks who will jam up CB for miles around with continuous recordings of highly distorted pop music and other obnoxious sounds, the mentally depraved types who will let forth endless transmissions of the vilest forms of obscenities, the "radio vandals" who by deliberate jamming, will wreck other users attempts at communication. .... *This is what licenced radio amateurs and other services are having to contend with now and attempts by the authorities to stop these offenders have so far proved completely ineffective.* Such activity would be multiplied by more than a thousand times on a CB band.

But say the CB advocates, it would be quite easy to identify all CB operators licensed or otherwise because all CB sets could be fitted with an encoded identification generator. *Could* is the operative word. Such devices could and would be disconnected, changed or modified in minutes by anyone with some knowledge of electronics. The cost of continuous monitoring, dealing with cases of interference and administration generally would far exceed any income likely to be obtained from equipment VAT and licences.

PHYSICAL VIOLENCE

In many countries CB radio has been the cause of physical violence and even murder brought about by face to face confrontation between CB operators resulting from arguments over the use of channels and interference to television and other reception.

It should also be remembered that CB would involve not only millions of people but young children as well and enticement by means of radio communication for the purpose of criminal assault would be far easier than by any other method. Young children with walkie-talkies would be at great risk in this respect. There is no need for the CB advocates to say this hasn't happened. It has!

A FLOOD OF IMPORTS?

The creation of thousands of new jobs for the production of and sales of CB equipment might well apply to Japan where most large electronics and radio manufacturers are ready now to begin mass production of CB equipment at prices no UK manufacturer could ever compete with and almost regardless of type, frequency or power requirements etc. The writer recently spent four weeks in Japan with one of their largest manufacturers of communications equipment who could meet most of the total demand in the UK within a matter of weeks and with CB sets that would meet any type approval specifications.

There is little point in speculating on a frequency band that might be allocated for CB in the UK, or indeed on any other technical performance parameters that might be specified. Frequencies around 200MHz have been mentioned largely because there is a band in this region claimed to be unused although in fact still allocated to the armed forces.

It remains for those who want CB radio in the UK to first get it legalised, but once allowed it could never be stopped no matter what havoc it would almost certainly create.

EE CROSSWORD No 19 BY D. P. NEWTON

Solution on page 599

ACROSS

1 Fruity layer, opaque to some wavelengths.
4 High conductivity harness.
7 What the DXer does when the signal comes in?
9 A neat Vesuvian cone (Anag.).
10 Component leg for line hanging.
12 Commonly bread but sometimes 10 across.
13 An underhand come-on filters through.
15 Friendly TV system.
17 
19 Lit upon a cast-iron term.
20 Cassette button for tape expulsion.
23 Booze in the alternator.
24 Reflect on it Snell for a pulse (Anag.).
25 Cancel.
28 Its purpose is to spin.
30 Run towards.
31 To make a components' union (6, 2).
32 Network for reaching the heights of addition?
33 Eee, an occasional condition affecting reception.

DOWN

1 Plan a mast sight (6, 4).
2 Pupil in a tone (Anag.).
3 It's not even evens.
4 Occupying a considerable width on the dial.
5 Between a part of interference.
6 Gives records and mass.
8 Celestial signal from earthly source (3, 4).
11 Five per cent band.
14 Shop for a memory unit?
15 Control backing.
16 Collapsible aerial.
18 Wheatstone's précis?
19 An easily-led circuit.
21 Greek tea makes tight.
22 Bug with dog connections.
26 Of some musical fame?
27 To exhibit strong influence in a pushy sort of way.
29 Inductive winding.

IT'S FREE

Our monthly Advance Advertising Bargains List gives details of bargains arriving or just arrived—often bargains which sell out before our advertisement can appear—it's an interesting list and it's free—just send S.A.E. Below are a few of the Bargains still available from previous lines.

5000 WATT HEATER KIT
Why not make a standby heater, you never know oil, gas even coal could run out this winter so be prepared and in any case a big heater is a good thing to have for an emergency. We are offering the kit at a very special price until September 30th only. The kit consists of:—two metal bladed tangential blowers, two 2·5 kW mineral filled metal clad heating elements, a three level switch, thermal safety cutout, mains and wiring connector panel, all the necessary tag ended leads and last but not least the wiring and assembly diagram. You have to provide the case material yourself, but our diagram gives all the details—the special off season price is £7·95 + £1·20, carriage £2. Price after September 30th is £11·50 + £1·75 + carriage.

HUMIDITY or the amount of water held in the air—it has a big effect on many things—unless the humidity is right for instance—chicken eggs won't hatch—tomato flowers won't set—cigars aren't fit to smoke—just to name a few, but most important is, we breathe the air, so humidity has a big effect on our health—air thats too dry makes us feel listless and also damages lungs and respiratory passages—too damp can kill us and in fact it does, fog (humidity 100%) is responsible for premature deaths of may people during winter months. Bearing in mind these facts its surprising that so few of us do anything to control humidity. This company sells a humidity controller switch made by Honeywell of U.S.A. price £1 + 15p, this adjustable for varying humidities and it will switch 10 amps at 240v—but its just a switch, and if one of our readers would design a simple to make humidifier, we will reward him and pass his design to any interested readers.

FLUORESCENT CHOKES
Another off season special offer. 80 watt chokes £1·75 + 27p, 65 watt £1·35 + 20p, 40 watt £1·25 + 18p. Prices are based upon an order for minimum of 20 chokes, but are subject to a discount of further 15% if you order 100 chokes. Try to collect but if not then add 25p per choke for carriage. Special Summer offer ends Sept. 31st.

RECORD PLAYER MOTORS
As fitted to Magnavox, B.S.R., Garrard etc. 2 pole motors £1·50 + 22p, post 35p. 4 pole (note these are also fitted to some tape recorders) £2 + 30p post 40p per motor. An interesting point about these motors is that they will replace a motor which is not quite the same, as the part with the winding on can usually be replaced separately

A DOOR SWITCH
Neat tubular pattern for letting into door frame. All you have to do is drill a ½" dia hole and chisel out for the fixing. This is a changeover switch, so can be used in opening or closing circuits. Price 57p.

CROUZET SKELETON MICRO SWITCH
Crouzet ref. 319/C this a changeover switch with unlimited uses, contacts rated 10 amps stackable and very light weight, snap action. Price 29p.

MINI DECADE THUMB WHEEL SWITCH
Stackable, panel hole size 1½" high and approx ½" for each switch. Matt black with white figures—gold plated break before make contacts. Price 87p.

ROCKER SWITCH
Double pole 13 amp 250v for hole size 1⅛" × ⅞" white with nickel plated surround. DOT ref. 82/631. Price 41p.

VARIABLE AUTO TRANSFORMERS (Variacs)
We have 12 only 8 amp variacs, these are unused being removed from new Ex Gov. power supplies—these variacs enable normal 230/40 mains to be varied smoothly from 0 volts to 270 volts in one volt steps. The current passing through the variac can be anything up to 8 amps continuous or 12 amps intermittent. These are ideal for dimming lighting or heating, speed control etc. and on the work bench for testing unknown transformers etc. The up to date price in the trade catalogue is £50 + vat, but our price is only £34·50 + £3 carriage.

MOTORS FOR VARIACS
Do you have a job which calls for the remote control of variacs—say the raising and lowering of the house lights in a theatre or the control of the air conditioning by thermostats set at different temperatures. If so you may like to know we have motorised cradles to take up to 4 variacs—mains operated, these drive the variacs backwards or forwards and have limit switches at the end of their 320° travel. Price £46 + carriage £5.

LOW TORQUE MICROSWITCH
Can be operated by air flow, coins or other small weights so they have many applications—SPDT silver contacts rated at 250v 5a expected life of 10,000,000 operations. Price 52p.

LIGHT DEPENDENT RESISTOR ORP12
A cadmium sulphide l.d.r. with clear end window—resistance reduces as light increases, dark resistance 1 meg plus, sun light resistance 100—200 ohms. Price 87p.

SUB MINI TRIMMING POTS
Wire leads suit 1 matrix board—top adjusting available in following values: 10 ohms, 10k, 20k, 50k, 100k, 200k, 250k, 500k and 1 meg. Price 74p each or 62p if ordered in ten of one value.

MULTI TURN POT
1¾" cermet—20 turn metal cased with three leads for p.c.b.—multi-contact wiper ensures minimum noise and excellent stability—slipping clutch end stop, one value only at present this is 2 kΩ. Price 63p.

SPECIAL CABLES
In addition to the list given in our May/June newsletter we have a few more to add—these have medium duty 7·0076 copper conductors P.V.C. insulated and colour coded, twisted into pairs, each pair braided with a metal screen then all are laid together and covered, black pvc 4 screened pairs 45p, 5 screened pairs 50p, 8 screened pairs 60p, 16 screened pairs 95p. All prices are per foot and subject to VAT and 60p carriage if order under £6.

POWERFUL LOW SPEED MOTOR
230v or 115v mains driven, 45 r.p.m. approx at 50 Mz 60 r.p.m. at 6 Mz. Size is approx 2¾" dia × 2½" deep ¼" dia shaft ¾" long—mountable from front or rear, this extremely powerful, in fact the writer could not stop it by hand. Price £3·75 + 56p, post 40p.

¼ H.P. MOTORS Normal base mounting, ex computors but tested, 230—240v 50 hz good length spindle mostly American make. Price £8·62 each, carriage £2·00.

STEREO HEADPHONE LEAD
Black curly 10ft approx. terminations, stereo jackplug one end—miniature two pin plugs on other. Price 57p.

MAINS OPERATED WATER PUMP
Most readers will know that we stock the Jabsco drill pump which was made to work with most portable drills, the price is £2·15, we have coupled this to an 110 rpm motor, mounted them on a metal chassis and offer this as a general purpose pump. It is suitable for most liquids and certainly for water. The pump will lift the liquid up to quite a head. Price £10·60, post £1·00.

HEAVY DUTY MAINS RELAY
With three c/o 15 amp contacts—fitted with plastic dust cover, this has push on tags for quick connections. Price £3·26.

MULLARD UNILEX

A mains operated 4 + 4 stereo system. Rated one of the finest performers in the stereo field this would make a wonderful gift for almost anyone in easy - to - assemble modular form and complete with a pair of speakers this should sell at about £30—but due to a special bulk-buy and as an incentive for you to buy this month we offer the system complete at only £15 including VAT and postage.

SHORTWAVE CRYSTAL SET

Although this uses no battery it gives really amazing results. You will receive an amazing assortment of stations over the 10, 25, 29, 31 metre bands. Kit contains chassis front panel and all the parts £2·30—crystal earphone 65p including VAT and postage.

RADIO STETHOSCOPE

Easiest way to fault find, traces, signal from aerial to a speaker, when signal stops you've found the fault. Use it on, Radio, TV, amplifier, anything. Kit comprises transistors and parts including probe tube and twin stetho-set £4·60.

WINDSCREEN WIPER CONTROL

Vary speed of your wiper to suit conditions. All parts and instructions to make £4·25.

DRILL CONTROLLER

Electronically changes speed from approximately 10 revs to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions. £3·75.

SOUND TO LIGHT UNIT

Will proved circuit flashes up to 750 watts of lamps. Complete kit includes S.C.P. mains input leads, all parts and very neat plastic case £4·95.

CASSETTE OUTFITS

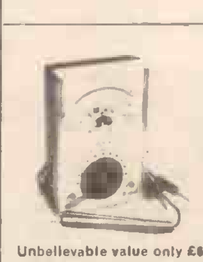
Complete mechanisms with record/playback and erase heads—all electronics and speaker £9·75 post and VAT paid. *Note* these are all cased up ready to use but case may be slightly uncomplete, cracked or broken.

VARICAP POCKET RECEIVER

CHASER DISPLAY

To quickly receive parts for these and other E.E. projects, send the approximate cost as shown. Any cash adjustment can be made later.

MINI-MULTI TESTER



Amazing. deluxe pocket size precision moving coil instrument jewelled bearings—1000 opv—mirrored scale.
11 instant ranges measure:—
DC volts 10, 50, 250, 1000
AC volts 10, 50, 250, 1000
DC amps 0-1mA and 0-100 mA
Continuity and resistance 0-150K ohms.
Complete with insulated probes, leads, battery, circuit diagram and instructions.

Unbelievable value only £6·50 + 50p post and insurance.

FREE Amps ranges kit enable you to read DC current from 0-10 amps, directly on the 0-10 scale. It's free if you purchase quickly but if you already own a mini tester and would like one send £1·50.

TERMS: Cash with order—but orders under £6 must add 50p to offset packing, etc.

BULK ENQUIRIES INVITED. PHONE: 01-688 1833.

ACCESS & BARCLAYCARD ACCEPTED

J. BULL (ELECTRICAL) LTD

(Dept. E.E.), 103 TAMWORTH RD., CROYDON CR8 1SG

LATCHING RELAY
This is in fact a double relay, mechanically arranged so that when relay no. 1 closes it will stay closed until no. 2 is closed. Each relay has its own coil (50v dc) and its own c/o contacts, useful in burglar alarm and similar circuits. Price £3·45.

DOUBLE ENDED MOTOR
Mains operated, capacitor run, power estimation at approx. ⅛ h.p., this has spindle coming out each side and should be very suitable for converting into a doubled ended polisher or grinder, holes conveniently placed in the housing make it very easy to stand in the right position and the speed although not high is adequate. We are offering these with capacitor at £4·70, post £1·50.

THREE POSITION ROCKER SWITCH
10 amp changeover with a centre off standard size pushes into hole size approx. 1" × 7/16". Special bargain this month, 10 for £2·30.

WATERPROOF HEATING WIRE
As used for electric blankets etc. This has dozens of other applications—in gloves or socks for people with poor circulation are obvious uses. One unusual use suggested by a customer is a 'grow' bag heater. The wire which consists of an element wound on glass fibre then covered by clear PVC has a resistance of 60 ohms per yard. The price is 23p per metre.

FAST RUNNING OUT
The miniature 24hr timer module, with facility for 32 on offs and 16 amp contacts. If you want one of these send your order this month or you will be too late. Price is £7·71. Extra on off triggers £1·15 per set.

ANOTHER UNREPEATABLE BARGAIN
Which will soon be sold out, is the Sensitive Voltmeter/Relay—fully described in our January newsletter—brand new offered at only about 1/10th of manufacturers price namely £8·93 and post £1. The 4½" 1 mA movement alone is worth more than double this and we give a circuit diagram of the non energy consuming relay/alarm circuit built into the voltmeter's case.

HALF PRICE CABLE OFFERS
Copper clad—made to B.S.I. specification. Prices are only about half the present list prices so be clever buy now while stocks last.

Size	Type	Price 100 metres	Carriage
1·5 mm	Single c.c.	£2·87	£1·00
1·5 mm	Single double insulated	£3·02	£1·50
1·5 mm	Flat twin	£5·17	£1·75
4 mm	Single c.c.	£8·72	£2·50
4 mm	Flat twin	£11·45	£3·00
6 mm	Flat three core	£25·92	£4·00
6 mm	Twin & E.	£25·92	£4·00
10 mm	Twin & E.	£40·25	£6·00
16 mm	Twin & E.	£62·20	£8·00

ELECTRICAL ACCESSORIES SUMMER PRICES
Waterproof cast metal thermostat box £2·87 + 37p post 40p.
Wall mounting Multiswitches metal box with front GEC, single switch 57p, twin switch 60p + 8p. Architrave single 69p. Architrave double 86p.
Quad switch 87p, 6 switch £1·15, 12 switch £1·73.
Switches for above 5 amp sp. 35p, 15 amp sp. 52p.
5 amp 2 way 40p, 2 way and off 58p.
13 amp sockets unswitched brown 34p + 4p, switched brown 59p.
Junction box 23p.
Spurs white 40p, with socket 66p.
16 line connecting box £1·70.
Dim and full switch, 4 pole c/o with centre off 10 amps. £1·15.
Water heater switch 20 amp 250v flush 57p.
5 amp 3 pin switched sockets, 5 for £1·70, unswitched 5 for £1·15
3 Bank rocker switch, interlocked for blow heaters 57p.
Waterproof 5 amp single pole 250v switch 32p.
Flexible conduit 5⁄8" and 7" internal dia. 34p per metre.
Garden waterproof flood lamp £6 + 60p.
Mem. switch ref. 1613 52p.
Mem. switch ref. 1600 34p.
Brown surface switch square or round 5 amp 250v 41p.
Immersion Heater 2 kw £3·45, 3 kw £4·60, thermostat £3·45.

THERMOSTAT WITH REMOTE PROBE
This is a Satchwell thermostat using sensor connected to the switch by a 26" length of capillery. Adjustable 30° to 140°F with control knob. Price £2·60.

4 WAY CONNECTOR BLOCKS
Twin grub screw in PVC type, 10 blocks for 69p + 9p.

DC VOLTAGE CHANGING
For operating 12v equipment from 6v car battery etc etc., based on a circuit which appeared in a recent addition of the Wireless World this device fills an urgent need in that it doubles a DC voltage (within the limits of the transistors used). The ones we supply are suitable for operating up to 40 volts so providing the final voltage does not exceed this then you can double any voltage you like (or you can treble it or alter it to suit yourself). The kit comprises—2 selected power transistors, 1⅛" ferrux pot core FX 2242, enamelled copper wire, electrolytic condenser for smoothing and heat sink etc. Price of the kit is £3·45, the case 80p extra.

COMPONENT BOARD Ref. W0998. This is a modern fibre glass board which contains a multitude of very useful parts, most important of which are:- 35 assorted rectifiers including four 3 amp 400v types (made up in a bridge), 8 transistors type BC 107 and 2 type BFY 51, electrolytic condensers, SCR ref. 2N 5062 250uf 100v DC and 100uf 25v DC, and over 100 other parts including variable, fixed and wire wound resistors, electrolytic and other condensers. A real snip at £1·15.

SUPER 2N3055
Transistor RCA 52360, in our experience this does all the 3055 can do but does it better, we have good stock of these price 57p.

SPEAKER CABINETS
Simulated teak finish, nice handy size 11" × 8" × 4½" approx. modern black sponge type front, price £2·36, post £1·50.

IN CAR SPEAKER CABINET
White with black edge very modern looking plastic with threaded studs for mounting speaker complete with back, price £1·75, post 60p.

AC CAPACITORS
For use on fluorescent lighting for power factor correction or as a voltage dropping device, these are very rugged and will stand DC voltages up to three times their RMS voltage. A big purchase enables us to offer these at about one third of the current manufacturers price, all are 300v RMS working or higher and are in aluminium cans with tags or wire ends, following values: 1·25uf 40p, 1·5uf, 52p 3uf 63p, 4uf 74p, 7uf 98p, 8uf 107p, 15uf £1·45p.

COMPUTOR COOLING FANS
The famous Plannair, these are a six bladed 4½" fan rotating at approx. 3000 revs per minute, in a die cast case size approx. 5" square with 4 fixing holes and cable entry box. Not new but any not in perfect working order would be replaced. Price £5·75 + 40p post.

Fluorescent Fittings definitely the time to think of lighting. We are making a special offer of fluorescent fittings to callers, complete with tubes, summer prices are 2 ft. £4·02, 1 metre £4·60, 4 ft £5·46, 5 ft £6·61.

Calculator Key pad Ex broken up calculators these are approx. 2½" square and have the normal 10-9 buttons plus on/off, divide, multiply, plus, minus buttons as well few only left of these 88p.

The Extraordinary Experiments of Professor Ernest Eversure

by Anthony John Bassett

Tom and Maurice are forming a Space Age Band with traditional instruments and electronic effects, plus as many unusual gadgets as they can lay their hands on. Last month we saw how the Prof. repaired a wah wah unit and suggested some unusual ways in which it could be used. Now he looks at a faulty spring line reverberation unit.

REVERB UNIT

"It seems there are a number of things wrong with this unit," the Prof. told Maurice, "not only electronic faults but also, from the way it rattled as you handed it to me, it seems there is a mechanical fault as well."

The Prof. examined the unit. "It works by means of springs which vibrate at audio frequencies and give the effect of very close echoes or "reverberation", and in some devices of this type a mechanical clamp is provided, to prevent the springs from vibrating when not in use, and especially when the unit is being transported.

"I see that this unit does not have such a clamp. Because of this it is unduly sensitive to vibration and knocks, and the end of one of the springs has become separated from its mounting."

MECHANICAL REPAIR

The spring mounting points were very delicate and not easily visible, so the Prof., after removing a small object from the loose end of the spring and leaving it to soak in a small glass jar containing some paint-remover, drew a sketch (Fig. 1).

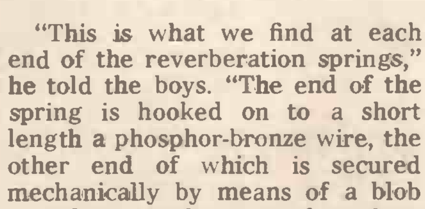


Fig. 1. Detail of the spring mounting point for the spring line reverberation unit.

"This is what we find at each end of the reverberation springs," he told the boys. "The end of the spring is hooked on to a short length a phosphor-bronze wire, the other end of which is secured mechanically by means of a blob of solder at the end of a short length of brass tubing held in place by clamps.

"Part way along the phosphor-bronze wire, a small magnetic bead is held in place by adhesive cement. The bead at one end of each spring is caused to vibrate by the magnetic field produced by audio-frequency currents in a nearby coil driven by a small amplifier. The magnetic field is guided to the magnetic bead by means of soft-iron pole pieces.

REFLECTIONS

"These vibrations are passed onto the spring, and travel along it at the speed of sound, being reflected back and forth along it to produce reverberation. Even though the speed of sound in steel is several times greater than in air, the vibrations travel back and forth along the spring a great many times and may give a decay time of several seconds.

"Thus the spring and both magnetic beads continue to vibrate even after the original audio signal has ceased, and this is picked up by a coil near to the second magnetic bead and converted to a reverberation signal, which is a replica of the original repeated many times by reflection back and forth.

"In this reverberation unit, the phosphor-bronze wire has broken off right inside the brass tube probably due to a heavy knock caused by dropping the equipment."

"I see," said Tom, "all it needs is a new piece of phosphor-wire!"

Easier said than done!" remarked Maurice. "In our studies of mechanical science and engineering at school, I learned that there are numerous grades of phosphor-bronze. Some are soft and ductile, whilst others are hard and strong. We need to be sure to use the right one."

"That's OK, I've got some phosphor-bronze wire of high tensile strength and almost the same gauge in the Laboratory Stores."

MAGNETIC BEAD

Bob used the Stores computer to locate the wire, and whilst he was cutting off a suitable length and carefully joining it to the end of the spring, the Prof. put on protective eye goggles and removed the magnetic bead from the jar of paint remover, which had successfully dissolved the cement which joined the bead to the old bit of wire. Being very careful not to get the paint solvent on his skin and clothes, he washed the magnetic bead in cold water, then in methylated spirit, which he allowed to dry before threading the bead onto the new length of phosphor-bronze wire which Bob had joined onto the spring.

The Prof. positioned the magnetic bead at the correct distance along the wire, then applied a couple of small blobs of quick-set adhesive to it, and also one to the point where the wire looped onto the spring. Leaving this to set, he applied a hot soldering iron to the solder at the end of the brass tube and removed most of the solder, so that the phosphor-bronze wire could now be threaded through the hole in the end of the tube.

LOW MELTING POINT

"That solder seemed to melt very quickly, Prof.," remarked Bob, "especially considering the bulk of the brass tube, which must surely act as a heat sink and take away some of the heat!"

"That's right, your sharp observation has scored again! It is low melting point-solder, so it melts very easily. We must use similar low-melting point solder to fix the phosphor-bronze wire into the brass tube. If the phosphor-bronze gets too hot, it becomes annealed and soft, loses much of its tensile strength and becomes liable to break again at exactly the same place."

Now Bob carefully threaded the end of the new piece of phosphor-bronze wire through the brass tube. He stretched the spring until the magnetic bead was in the right place, between the pole-pieces of the coil, and held the wire with narrow snipe nosed pliers whilst the Prof. quickly and carefully soldered it into place in the end of the brass tube, using low melting point solder. When the solder had set, Bob cut off the surplus wire leaving about 1cm of spare wire protruding from the end of the brass tube.

"Now we should need only to repair the electronic faults, to have a working reverb unit," the Prof. observed.

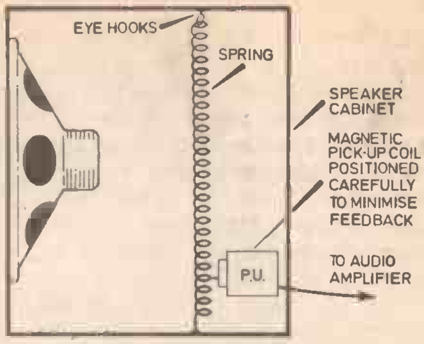


Fig. 3. The Prof's idea for a simple spring line unit.

The signal could be fed to one of the inputs of the amplifier to be heard from the speaker as a reverberation effect.

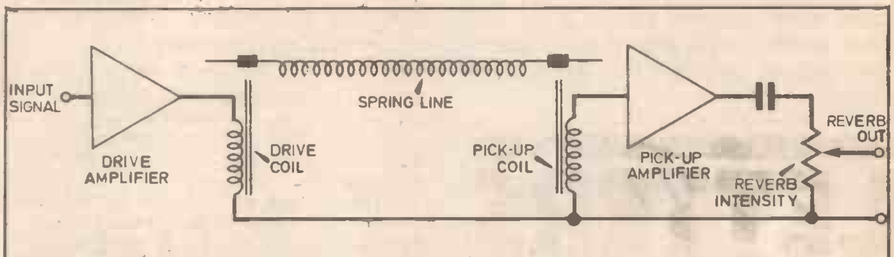


Fig. 2. The Prof's block diagram for explaining the operation of the spring line reverb.

SIMPLE REVERB

"Prof. I've been having some thoughts about spring line reverberation and I've got an idea I'd like to ask you about." Bob began to draw two sketches (Figs. 2 and 3).

"The first diagram, Fig. 2 shows very basically how I think the unit produces an electronic reverberation signal," he told the Prof.

"The original signal is fed into the 'drive amplifier' and the output of which causes the spring to vibrate through the drive coil as you described earlier.

"The pickup coil then feeds the electronic reverberation signal to the 'pickup amplifier' the output signal is then mixed with other signals and eventually fed to the loudspeaker.

"Now I've thought of a very simple and inexpensive way to build a spring line reverb unit with much less electronics" he indicated the next diagram, Fig. 3.

"My idea is to simply stretch a steel spring across the inside of a loudspeaker cabinet, and put a magnetic pickup near it. Any sound from the speaker will cause the spring to vibrate, and the pickup will then detect any reverberation signal from the vibrating spring.

The total cost to someone who already has an amplifier and speaker would be just the cost of a thin steel spring and a pickup!"

"That is a good idea, Bob, and it can be made to work quite well, however in order to get the best results it is necessary to position the spring carefully so as not to

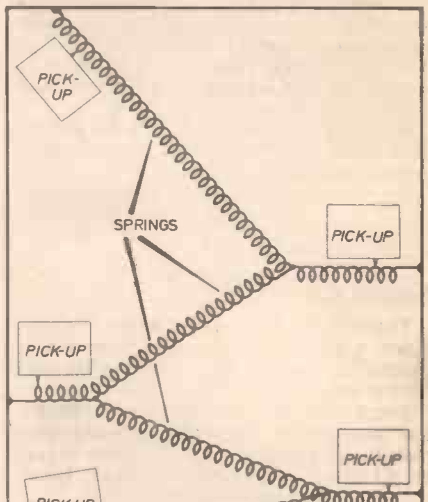


Fig. 4. Obtaining a more complex reverberation by using a long spring in zigzag fashion. Replacing the spring with guitar strings will produce Sitar sounds.

pick up too much unwanted resonance. Also, the pickup must be positioned carefully in order to receive the best possible signal from the spring without picking up too much of the audio frequency magnetic field from the speech coil of the speaker. This could cause unwanted oscillations resulting in a howling or whistling sound.

"If a longer spring is used, stretched inside the speaker cabinet in zigzag manner with each portion being a different length, this should give a more complex reverberation sound and help to reduce dominant resonances." The Prof. drew another diagam, Fig. 4, to show this.

"Here several pickups can be tried at whichever points give the best results, and the signals from the various pickups can be mixed together.

" A similar method can be used to deliberately boost a number of resonances, producing an interesting sitar-like effect.

SITAR SOUNDS

"The sitar-like effect may be accomplished by stretching a number of guitar strings across the inside of the loudspeaker cabinet, and tuning them to the various high pitches. By picking up the vibrations of these strings with the magnetic pickups and feeding them into an amplifier, weird overtones are heard, and may linger on noticeably as the playing changes.

"Once again it is necessary to position the pickups carefully to avoid magnetic feedback, and it is also helpful to feed them into a second amplifier and speaker, rather than back into the amplifier which drives the experimental cabinet."

To be continued

Crossword No. 19—Solution

LETTERS

Challenging Project

I am building the EE2020 Amplifier and am reaching the final assembly stage. Obviously I want the unit to look as "professional" as possible and the key to this is the appearance of the front panel.

Out of interest I approached one of the suppliers of metalwork to my own company and he quoted £48·00 for 1 off anodised and engraved panel!!

The pictures which you show of the amplifier appear to show that the front panel has a printed label fixed to it. If this is the case I would like to know if such a label is available and, if so, how much it would cost.

May I say that I have found the project challenging and that I consider it a credit to your magazine.

J. Simmonds,
Yateley, Camberley,
Surrey.

The front panel of the EE2020 can be marked as follows: Roughen the surface of the aluminium, then clean thoroughly. Apply Letraset or "Blick" dry print. Spray with clear varnish—nail varnish will do—or hair lacquer.

This method is easy and economical and gives a "professional" finish. Engraving is certainly a rather costly process.

Regarding the tuning scale, you should be able to make a fair copy on white card from the published diagram. Incidentally the variations in dial markings are due to the non-linear capacitance/voltage relationship of the varicaps used in the tuning system; the overall calibration should be within + or −0·5MHz which for a project of this type is quite good. If you have access to an f.m. signal generator you could of course calibrate the dial with better accuracy.

Sounds Good

Thank you for your helpful advice when I spoke to you by telephone a couple of weeks ago about distortion on the sound, and an a.f.c. fault.

Since speaking to you I have corrected the fault on the sound and found also that the steady rise and fall in the signal on a.f.c. has also corrected itself, being eliminated by correctly tuning L2.

The fault on the sound was cured by replacing the 1 kilohm resistor R45a,b by 10 kilohm resistors which altered the collector voltage of TR6a,b, from 20V (with fault present) to the correct 11V. I am not sure why a 10kilohm resistor was needed but I wondered if it could be associated with using BC184B transistors instead of BC384L.

I wonder also if I could ask you about a few further points which I am not sure about please. These are:

(1) The voltage at TA5 is 0·6V approximately instead of the stated 7V.
(2) The voltage at TR3a,b base is 3·6V approximately instead of the stated 6·8V.
(3) When using the mute switch the strong signals are unaffected but the weaker signals can't be tuned in.
(4) When tuning manually with a.f.c. selected, the station is held over a considerable section of the scale, i.e. the effect is to spread the station.
(5) When tuning to a weak signal which is adjacent to a strong signal on the scale, when a.f.c. is selected the strong signal is brought in in preference to the weaker one.

Finally I would like to tell you how delighted I am with the overall result. I have really enjoyed every hour spent working on it and I must say the sound coming from my speakers is of a very high quality indeed.

My grateful thanks to yourselves and the brilliant Mr. Rule.

I. B. Morris,
Liverpool.

Mr. Rule replies . . .

I'm not sure why changing the 1kilohm (R45) to 10kilohm should clear your other problem of distortion unless perhaps TR6 was faulty, in which case TR5 would work as an emitter follower and this could account for the need to change R45. It would be worth checking this part of the circuit again and making sure that TR6 is o.k. What you have done is all right except that if TR6 is not working the distortion through the stage will be higher than it should, although perhaps not enough to notice in practice.

The difference in voltages that you are getting on certain test points is almost certain to be due to the resistance of your meter effecting the readings. This often happens when measuring base voltages of transistors and the best way is to measure the emitter voltage and add on approximately 0·6 volts. This will then give you the actual base voltage, providing of course that the transistor is working.

The mute switch will only effect the weaker signals and the background hiss. Strong signals are not effected.

When using a.f.c., a nearby strong signal will pull the receiver away from a weak one if the strong signal is within the i.f. pass band; this is normal and the only answer is to leave the a.f.c. "off" when tuned to weak signals. When a.f.c. is "on" tuning along the scale will give the effect you mention of very broad tuning. This is also normal and in fact shows the a.f.c. is working—it is trying to correct the tuning error you have introduced by trying to detune the station with the normal tuning control.

From all your comments I would think that with the possible exception of TR6 your EE2020 is working correctly and I am very pleased to hear of your satisfaction with your efforts. The EE2020 was a large project compared with most and judging by the letters received, the staff of Everyday Electronics *did a good job as there have been very few problems reported to me by constructors.*

Should you have any further queries please let me know but in the meantime I wish you many hours of good hi-fi.

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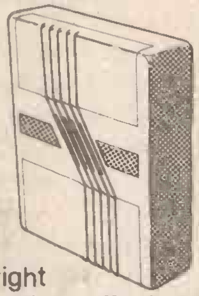

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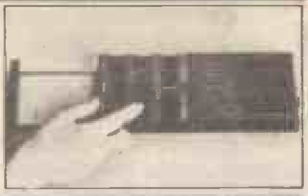

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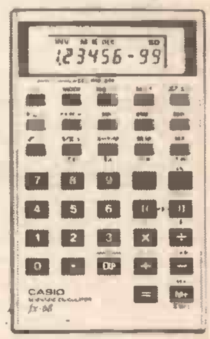

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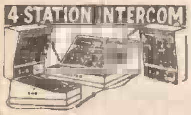

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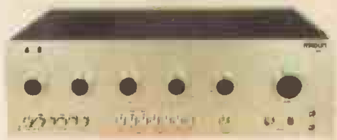

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